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Combined Steam and Hydraulic Station

STEAM AND WATER-DRIVEN UNITS OPERATING IN PARALLEL AT DIFFERENT VOLTAGES IN KANKAKEE PLANT OF PUBLIC SERVICE CO. OF NORTHERN ILLINOIS

ON THE SOUTH BANK of the Kankakee River and at the corner of West Ave. and Water St. in the city of Kankakee, Ill., may be found one of the most ideal power plants, located in that part of the state, for the utilization of both steam and water for the generation of electric power.

The external appearance of the building, of red brick construction, with its large windows, and surrounded by its green grass plots and cinder drives, is most impressive upon the visitor. For additional general appearance, and to aid in the illumination of the grounds at night, numerous one-lamp standards have been placed along the driveways and walks. Great is the contrast between this station and that of the old one on the opposite bank, which, though still in operation, will eventually be shut down, as soon as the necessary changes can be made to do so.

Though comparatively small in capacity, the new plant is representative of modern central station construction as adopted by large public service companies.

When owned and controlled by what was then known as the Kankakee Gas & Electric Co., this plant consisted merely of the steam equipment, part of which is still there, and was used as a reserve to the old hydraulic station on the other side of the river. The Public Service Co. of Northern Illinois was, however, ready to see

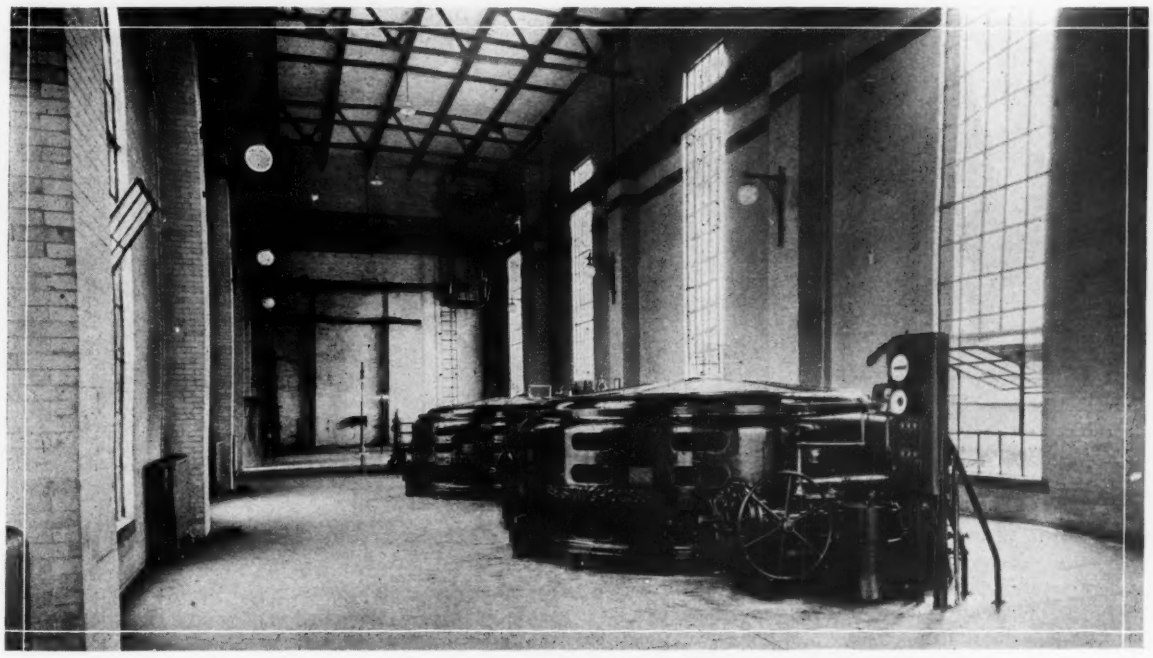


FIG. 1. HYDRAULIC TURBINE ROOM OF KANKAKEE PLANT

the advantages to be gained by combining the 2 stations, the partial results of which may be seen, and which will be still further realized when the old plant is entirely done away with.

Coal Handling Equipment

Coal used at this plant is run of mine, obtained from the Springfield, Ill., district and is shipped to Kankakee over the Illinois Central Railroad. From the cars, the coal is dumped into a hopper located about 126 ft. from the plant, and leaving this, it passes through a crusher and onto a belt conveyor, by means of which it is carried through an underground tunnel, dumped onto an elevator and brought in front of the boilers.

For local deliveries by wagon or truck, a smaller hopper is provided near the building proper, and coal dumped therein is caught by the conveyor without being crushed and carried to the boiler room.

Boilers and Auxiliaries

Boiler equipment consists of 5 hand-fired Frost tubular boilers, 72 in. by 18 ft., operated at 150 lb. pressure.

Three iron stacks are provided, 2 for 2 boilers each and one for the remaining unit. Open space at the west end of the room, reserved for any additional units, is at present utilized as a general repair shop, while on the east side is a small room containing the Cochrane feed water heater and one Deane of Holyoke 12 by 7 by 12-in. simplex outside packed plunger pump and one Fairbanks-Morse 7 by 4½ by 10-in. duplex pump, both of which are used for boiler feed purposes.

An iron gangway, reached by means of an iron ladder, is built a few feet above the boiler tops, and is used to reach the boiler shut-off valves. All steam piping in the boiler room, together with the pumps and heaters are painted an olive green, which not only is pleasing in appearance but prevents the unsightly appearance of dirt, so noticeable on light colored asbestos covered piping.

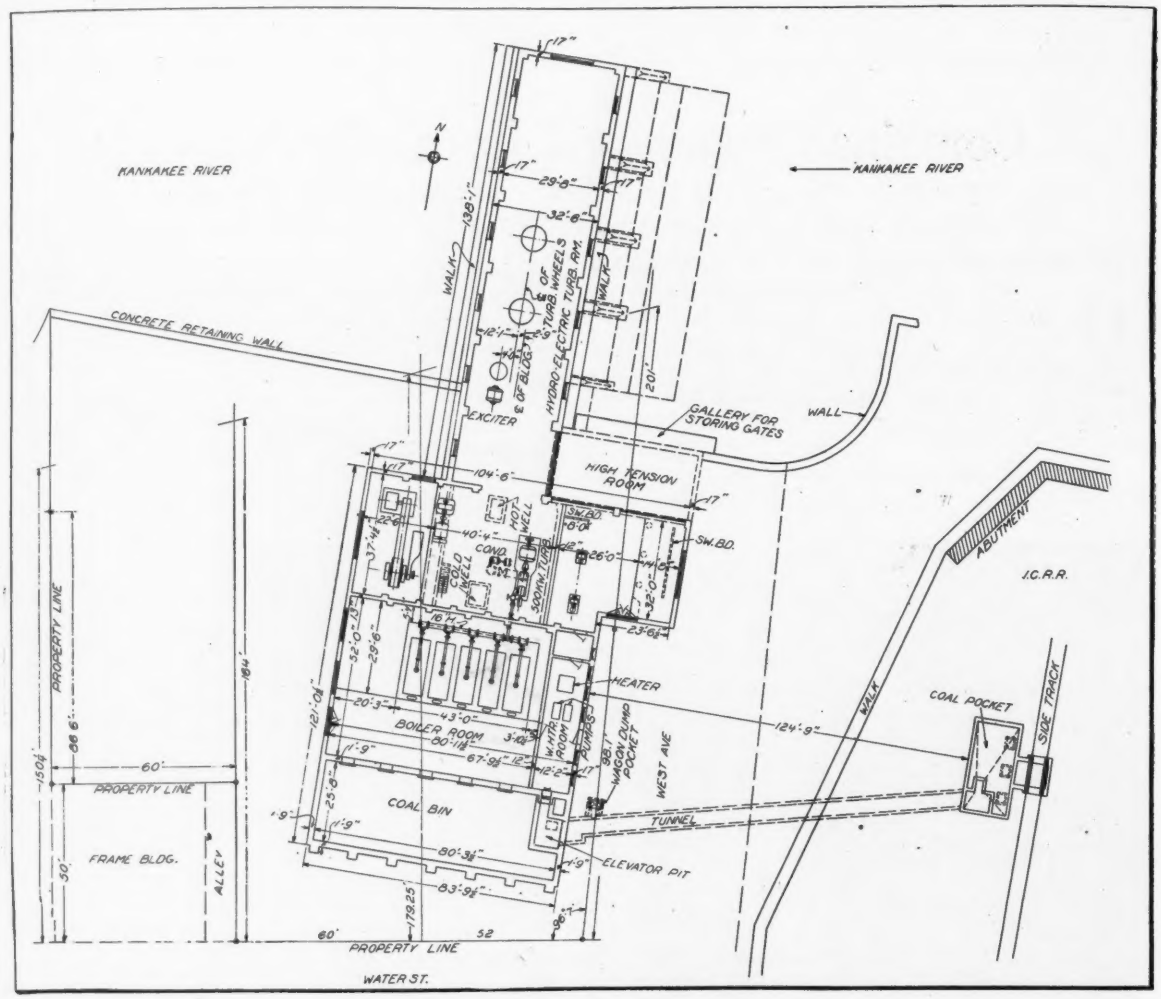


FIG. 3. PLAN OF KANKAKEE POWER PLANT

Engine Room Equipment

Two main units consisting of a Buckeye automatic engine belted to a 240-kw., 2300-volt, 3-phase, 60-cycle revolving field alternator and a Westinghouse-Parsons turbo-alternator rated at 500 kw., 2300 volts, 3-phase,

60-cycle, at 3600 r.p.m., make up the steam generating equipment.

A 5 by 5-in. American Blower Co.'s engine, direct-connected to a 9.5-kw., 125-volt, Westinghouse direct-current generator, and a 10 by 18 by 10-in., Westinghouse automatic compound engine, direct connected to a 400-amp., 125-volt, General Electric direct-current

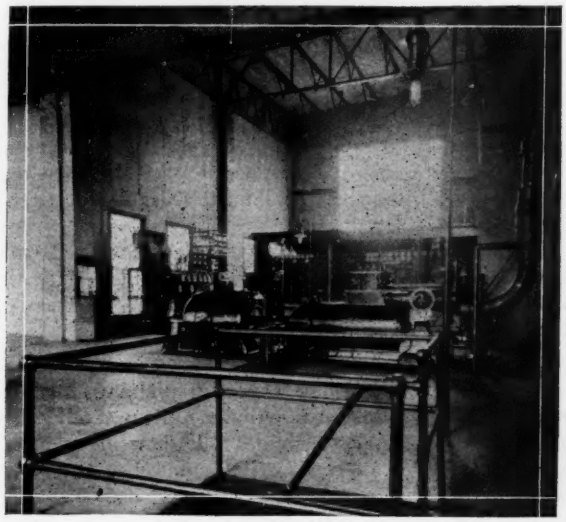


FIG. 2. ENGINE ROOM; WESTINGHOUSE-PARSONS TURBINE AND SWITCHBOARD IN BACKGROUND

generator, together with a 10-kw., 125-volt Westinghouse direct-current generator driven by a type CCL, 15-hp. Westinghouse 3-phase induction motor, constitute the equipment used for excitation.

Figure 2 shows the engine room looking east toward the Westinghouse-Parsons turbine, with the switchboard

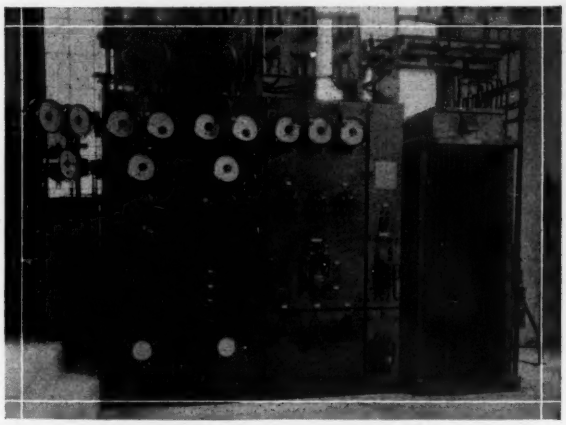


FIG. 4. STEAM GENERATOR STATION SERVICE AND AUTO TRANSFORMER PANELS; AUTO TRANSFORMER AT RIGHT

in the background. The motor-driven and the American Blower engine driven exciters are located between the turbine and switchboard as the plan, Fig. 3, shows.

At the west end of the engine room are located the Westinghouse automatic compound and Buckeye driven units.

Of these various steam driven units, the turbine, the only one operating condensing, is connected to a Westinghouse-LeBlanc condenser, the other units exhausting through the feedwater heater and into the atmosphere.

Hydro Units

Hydraulic equipment of the station is installed in a bay 32 ft. 6 in. wide, extending north over the Kankakee River for a distance of 138 ft. from the main building. To conform with the rest of the building, it is built up of pressed brick, red on the outside and a light grey on the inside, and provided with a concrete roof supported by flat steel trusses, as shown in Fig. 1.

For installation and repair purposes, the hydraulic turbine room is equipped with a 15-ton Whiting Foundry Equipment Co. electric crane.

At the present time, there are installed 2 Westinghouse umbrella type alternators, rated at 300 k.v.a., 4000 volts, 3-phase, 60-cycle, and operating at 72 r.p.m., and 1 Westinghouse 400-amp., 125-volt, direct-current generator, operating at 275 r.p.m. and used as an exciter

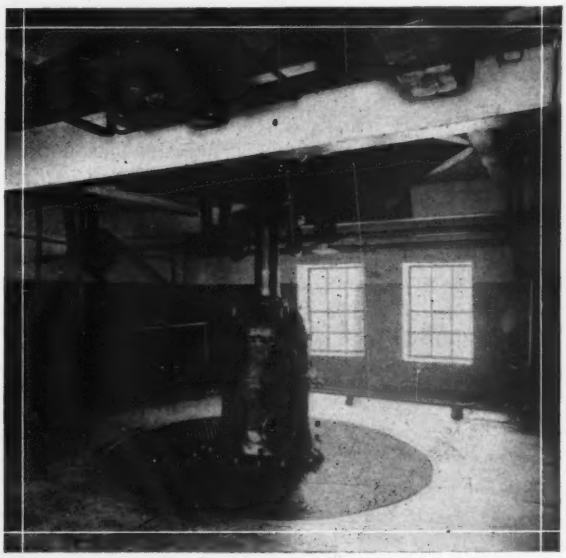


FIG. 5. THRUST BEARING CHAMBER UNDER GENERATOR NO. 1

for the other 2 hydro units. As shown in the foreground of Fig. 1, each of the 2 main generating units is provided with an operating panel, having mounted on it a frequency meter, a kilowatt-meter, and the necessary signal lamps and switches for communication to and from the switchboard operator.

The hydraulic turbines, which operate under 8½ ft. head of water, were built and supplied by the S. Morgan Smith Co., of York, Pa., and consist of a pair of "Smith" wicket gate machines, having 63-in. wheels mounted on a vertical shaft and placed one above the other. Both turbines discharge downward, the upper one through a cast-iron elbow and a concrete draft tube and the lower wheel into a concrete pit. The weight of the generator rotor, shaft, turbine runners, as well as the downward thrust, are carried by a special thrust bearing located in a compartment below the generators and shown in Fig. 5.

Switchboard Equipment

This consists of practically 2 separate boards located in the east bay of the engine room, one being near the east wall and the other near the north wall. The one near the north wall, which is the smaller of the 2,

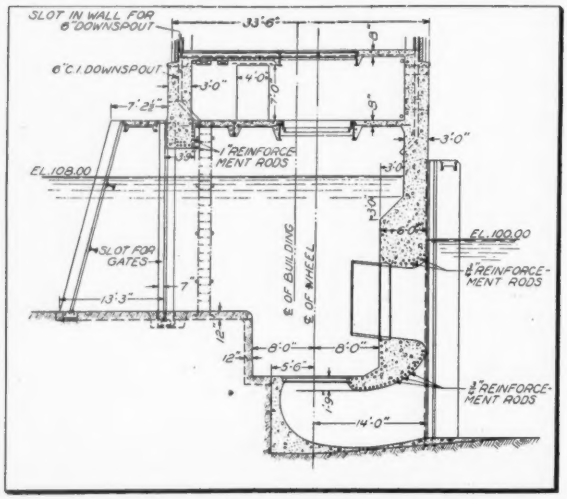


FIG. 6. SECTION OF TURBINE FOUNDATION

consists of 3 slate panels controlling the 240-kw. Westinghouse generator, the 500-kw. Westinghouse-Parsons turbo-generator, and the station service. The use of the fourth narrow panel, as illustrated in Fig. 4, will be explained later.

This board has the necessary ammeters, voltmeters, integrating wattmeters and synchroscopes, rheostats, field switches, oil switches, synchronizing and voltmeter receptacles and Tirrill voltage regulator.

The board on the east end, although consisting of 12 slate panels, has but part of these in use, 2 hydro-generator panels, 1 hydro-exciter panel, 1 Tirrill voltage regulator panel and 1 autotransformer panel which is identical with the narrow one on the other board, while the other 3 are commercial feeder panels.

The autotransformer panels referred to above are used in connection with an interesting operating feature of this equipment. As will be noted in the description of the alternating-current generators, the steam-driven machines operate at 2300 volts while the hydraulic units are rated at 4000 volts. It is evident that these voltages do not allow of the parallel operation of the steam and hydraulic units, and to overcome this an autotransformer, having a voltage ratio of 4000 to 2300 was interposed between the busbars of the 2 boards, which resulted in the satisfactory operation of all machines in parallel.

The station is tied in with the old plant on the opposite bank by 2 tie cables and with the company's steam station at Blue Island, Ill., by means of a 33,000-volt transmission line, this arrangement allowing of an exceedingly flexible system which is of great necessity in case of trouble to any part of the system. The value of this can be realized when one knows the present day load is greater than the combined hydraulic units can carry.

Figure 6 shows a section of the turbine foundations and Fig. 7 illustrates the old plant, at extreme left, the dam, the north bay of new hydro station, and engine room and boiler room at right.

An engineer of long experience, claims that the only reliable way to test a cylinder oil is actually using it in the engines. Most engines will show in some way any lack of lubrication, a Corliss engine usually having a slight groaning of the valves, while a balanced valve engine will show a rattling of governor connections, of the eccentric and of the valves in the chest.

To compare two oils, they should be used on the same engine for an equal length of time, and under as nearly the same conditions as possible, noting the amount of oil needed, and the effect on the bearings. No load indicator diagrams should be taken, if possible, at frequent intervals during each test, to determine the effect of oil upon the friction load of the engine. A satisfactory cylinder lubrication will be indicated by a dark, glossy appearance and coat of oil on the cylinder walls. If wiping the walls with a piece of soft paper, such as ordinary newspaper, shows a stain on the paper, the lubrication is good. If there is no oil stain, and the surfaces have a dull appearance, it is a sign of metallic wear and the oil is not lubricating properly, assuming that the engine was in fairly good working condition at the start of the test.

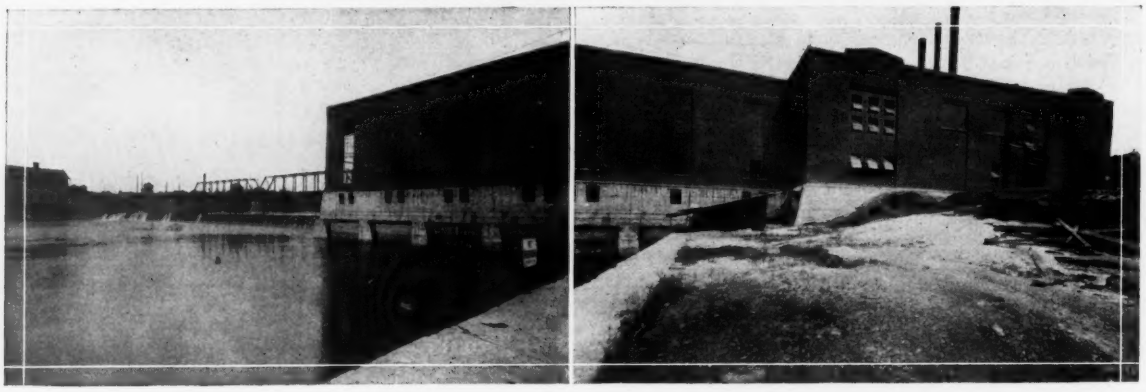


FIG. 7. OLD STATION AND DAM AT LEFT; NEW PLANT AT RIGHT COMBINED STEAM AND HYDRAULIC STATION

Engine Speed Governors

TYPES AND CHARACTERISTICS OF MODERN GOVERNORS. BY STERLING H. BUNNELL

SPEED governors in common use comprise the fly-ball, gravity-loaded type, the centrifugal, spring-loaded type, the single-arm, inertia-controlled type.

The fly-ball governor was the earliest form invented. In its simplest form, Fig. 1, it consists of an upright shaft, to the top of which are hinged 2 arms, each carrying a weight at its free end. Regardless of the length of arm, or amount of weight, the height from center of weights to hinge-point of arms is the same in all governors at any given speed. With speed as low as 30 or 40 r.p.m., the arms hang well down, and the weights swing up a satisfactory distance with a speed change of 2 or 3 per cent. But a trifling pull or push serves to disturb the position of the weights at such slow speeds, so that the usefulness of the governor is seriously limited by its lack of power to move anything connected to it. Speeding the governor faster causes the balls to run higher, and to oppose more resistance to a change of position, but now the arms lie so near to the horizontal that a 2 or 3 per cent change of speed causes hardly any change in height.

Movement of the fly-ball governor may be increased by using springs instead of gravity to oppose the centrifugal force,—Fig. 2. In either type, however, the strength of the governor is limited. The fly-ball governor must therefore be connected to an extremely light regulating valve. To get much change in the position of the valve, there must be a considerable change in speed.

By adding a heavy weight sliding on the vertical shaft of the fly-ball governor, and linking the weight to the ball-arms, the balls are pulled down, and the height from ball centers to hinge-point is increased at any given speed. Weighted down in this way, the governor balls rise further with a small speed-change, making the governor more sensitive. The heavy weight has another useful effect, through its inertia. By resisting any tendency of the balls to jerk it up suddenly, the weight steadies the action of the governor under change in speed. The fly-ball governor with central weight gains therefore in power, sensitivity and steadiness. It was first developed for the Porter-Allen engine, where its power was sufficient to operate a form of link-motion valve gear, and its other characteristics were good enough for regulating a successful high-speed engine.

These governors, Fig. 3 and Fig. 4, have also become the standard for Corliss engines. The knock-off arms of the steam-inlet valves require little force to shift to position, but react with sudden jerks on the governor connections as the lifting toes of the hooks strike them, and so tend to disturb the running position of the governor. To check this effect, an oil dashpot is always provided, opposing slight resistance to the gradual movement of the governor under change of speed, but great resistance to shifting suddenly under valve gear shock.

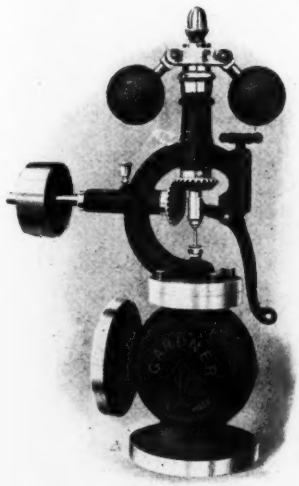


FIG. 1. CENTRIFUGAL BALL GRAVITY LOADED GOVERNOR

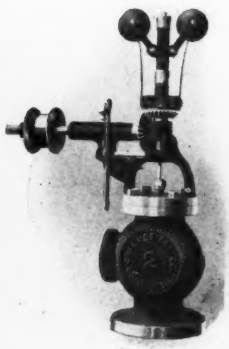


FIG. 2. SPRING LOADED CENTRIFUGAL BALL GOVERNOR

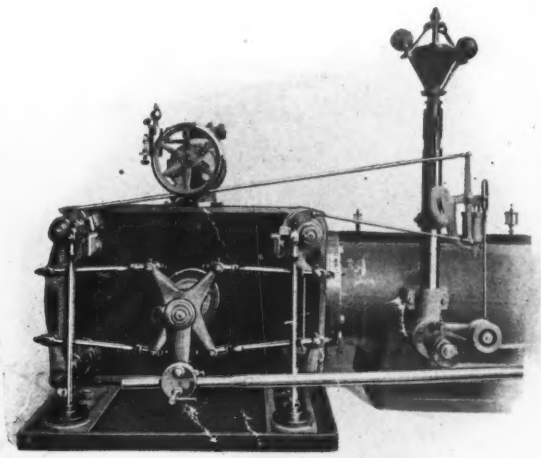


FIG. 3. CENTRIFUGAL BALL GOVERNOR WITH CENTRAL WEIGHT

The fly-ball governor with central weight and dashpot is the most conveniently flexible of all devices for accurate speed control. By changing the amount of weight, the working height of the governor can be kept the same for any desired speed within a considerable range. This adjustment is conveniently made by sliding a weight on a lever of the system connecting the governor with the valve mechanism. Another method is to provide an adjustable spring in place of the weight. The entire central weight may, if desired, be substituted by one or more springs exerting a force equal to the weight they replace. The effect of the springs will differ from that of weights by the fact that they have little inertia, and so do not oppose resistance proportional to the speed of movement. A spring-loaded ball governor therefore

needs a stiffer dashpot to check irregular vibrations, than does a weight-loaded governor.

Except with Porter-Allen valve gear, or Corliss or other cam-actuated valves, the ball governor can be used only to throttle the steam supply to an engine with fixed cutoff. This method of governing is that used on the cheapest engines for service where neither close regulation nor economy in steam is necessary. Surprising to state, it is, however, the proper method of speed regulation wherever it is desired to adjust the speed of engines between wide limits while running, and maintain any required speed with great accuracy. Double-crank engines with this type of governing are used to operate paper machinery, with which any variation from the set speed would change the thickness of the product. With less rigorous exaction in speed, asphalt machinery, glass grinding tables and many other machines are best driven by throttling engines.

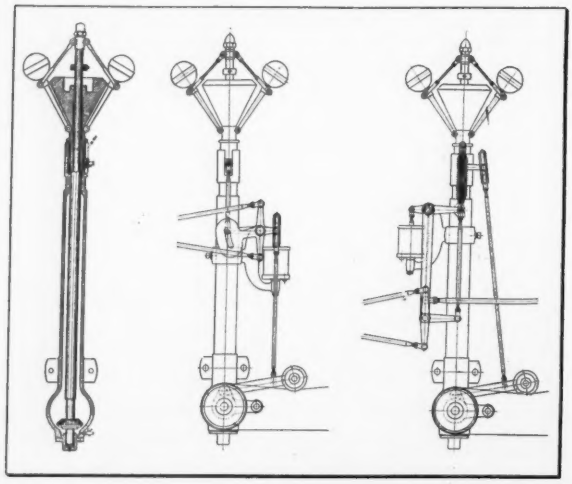


FIG. 4. DETAILS OF CENTRIFUGAL BALL GOVERNOR AS APPLIED TO NORDBERG CORLISS ENGINES

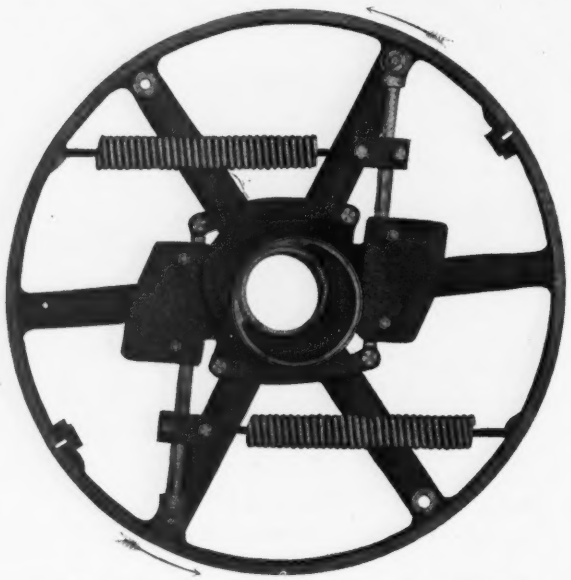


FIG. 5. BALANCED CENTRIFUGAL SHAFT GOVERNOR

For all such services, the engine should have the cutoff adjustable by hand, either while running, or when shut down. The governor should be a well-made center-weighted fly-ball type of ample power to actuate its balanced throttling steam valve. The speed adjustment should be made by either spring and tension screw, or sliding weight on a lever arm, up to the limit of range possible without overloading the joints of the governor and making it sluggish and stiff in action. This condition allows generally about 20 per cent speed change above or below a mean, or a total range of 40 per cent. If greater range is required, the speed of the engine shaft relatively to the governor-spindle must be changed, by some variable transmission device.

Several forms of friction speed variator, especially intended for use on ball governors, have been put on the market. The trouble to anticipate with all of them is uncertainty of speed due to changing conditions of friction surface. A drop of oil will reach the friction wheels, and the engine will gain one or more per cent in speed; while a little dust may speed up the friction wheels and slow the engine down.

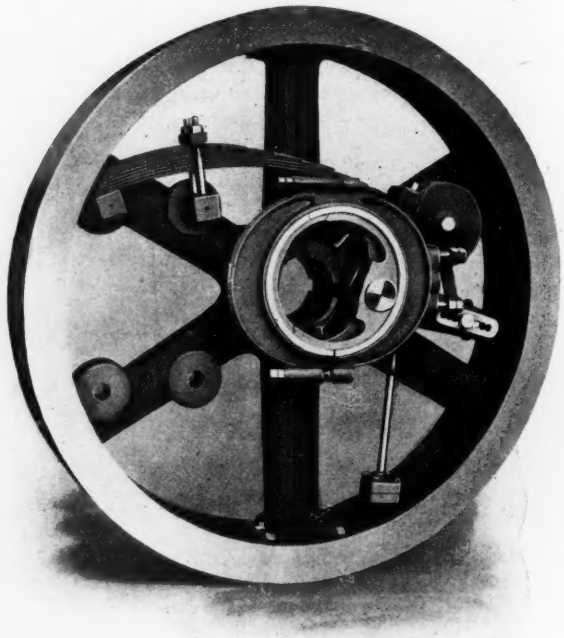


FIG. 6. SHAFT GOVERNOR WITH WEIGHT BALANCED BY ECCENTRIC ARM

All trouble from this source may be prevented by providing the governor with a regular change-gear box like that used on many engine lathes. With the first gear adapted to give the engine the slowest desired speed, and each gear thereafter increasing the speed in the ratio of 1:1.2, any given speed may be reached by one gear-shift, followed by adjustment of the governor. The ratio can be increased, if desired, to 1:1.4, but that would make it impossible to adjust to a speed nearly half-way between the normal speed of 2 successive gears, without often having to shift gears and readjust the governor. With a low ratio between successive pairs of gears, there will be a good overlap, so that either of 2

adjacent pairs of gears will bring the speed within the range of adjustment of the spring or sliding weight.

When the shaft of the centrifugal governor is to be placed horizontally, as with the governor shown by Fig. 5, springs, instead of gravity, must be used to oppose the centrifugal force. There is then no limit to the amount of mass, movement of governor arms, or speed, so that a governor of any desired power can be constructed. In designing the governor, the springs and weights are calculated so that the centifugal force of the weights will be balanced by the spring tension, both when the weights are in inmost position at the standard speed and when the weights are in outermost position at somewhat greater speed.

If a shaft governor is designed so as to shift its valve eccentric all the way from zero to full-load position with too small a decrease of speed, the weights when changing position are likely to over-run and change the cut-off too much, so that the engine will speed up, the weights will swing out again, and the action will continue in what is termed "hunting." A friction brake, or a dashpot, is sometimes introduced to check hunting.

Hunting is to a certain extent automatically opposed by an inertia effect which exists in shaft governors. An increase in revolution speed increases the centrifugal force by a small amount. As the weights trail behind their pivots, they must be moved forward as well as outward, into a path of greater velocity, nearer the rim of the wheel. As it takes time for the small excess of force to speed up the heavy weights, the result is a damping action tending to prevent sudden jumping of governor weights, during changes in speed.

Very successful shaft governors, Fig. 6, are also made with one centrifugal weight only. In them the weight is balanced as to gravity effect by the weight of the arm carrying the eccentric, the 2 arms being linked together so as to move in opposite directions from the center of the wheel. The weight supporting arm may consist of a leaf spring, carrying the weight at its free end. If the leaves are kept well oiled, so as not to dry out and rust, the action of the governor is quick, smooth and effective.

By reversing the motion of the governor wheel so that the weight runs ahead of its pivot, and spreading the weight itself out into a long bar, the inertia governor, Fig. 7, is derived. The centrifugal governor with its compact weights would jump unmanageably if run with the weight ahead of the pivot, but with the weight in the form of a bar lying across the face of the governor wheel, an inertia effect is introduced which prevents irregular movements. In fact, even the effect of gravity towards pulling the weight alternating out and in as the wheel revolves, is so much checked that the balancing effect of 2 opposite weights is unnecessary, and the inertia governor is conveniently reduced to a single heavy bar-weight and a spring.

The inertia governor is the quickest-acting type possible to construct. When the engine speed increases, the governor wheel overruns the governor arm until the latter reaches the proper position—a direct and rapid action, instead of the indirect and slower action of the centrifugal shaft governor, following a change in centrifugal force. The designing problem of the inertia governor is to check governing action that may be too quick, rather than to speed up action that may be too slow. Its faults are the greater weight of the inertia arm as compared with the weights of the centrifugal governor, and the insufficiency of the inertia effect at low speed, making most inertia governors pound on the stops when starting and stopping the engine, and many large ones at slow speeds give trouble by irregular movements induced by gravity. The inertia governing effect is so strong and positive that a certain amount of friction in the governor pivot, or elsewhere on the arm, improves the action. A big pivot pin with grease lubrication works well, while a nice smooth pin of small size, or a roller bushing, makes the governor unmanageable except by putting the friction in somewhere else, as by a drag or dashpot.

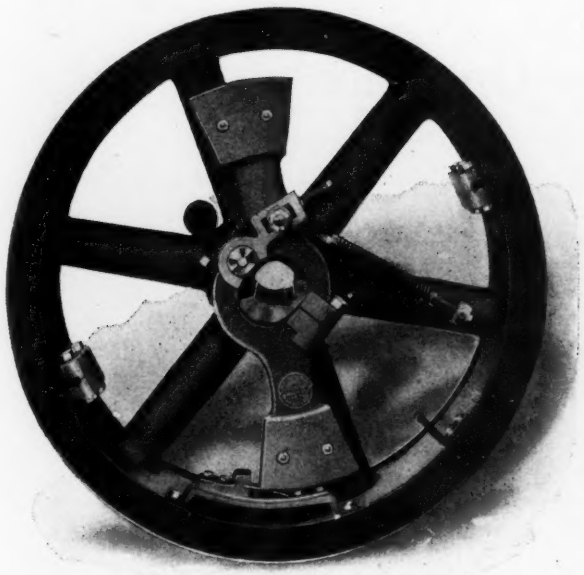


FIG. 7. INERTIA GOVERNOR

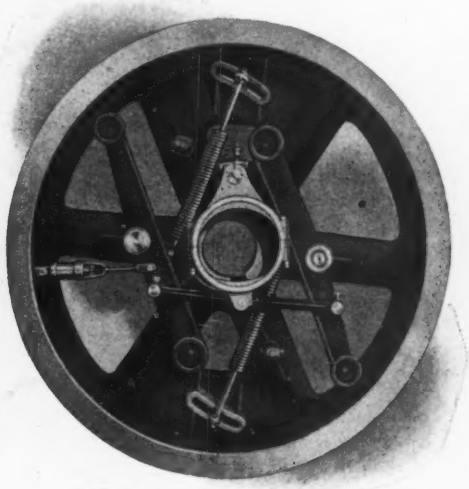


FIG. 8. DOUBLE BALANCED INERTIA GOVERNOR

For the single arm inertia governor, the proper field is on small and medium sized high-speed engines for direct connected service. Under varying loads, the speed regulation of this form of governor is unequaled. With engines of the larger sizes, good service can be obtained from the inertia governor by introducing a friction drag, rather than a dashpot. With still larger engines, the effect of gravity on the unbalanced weight becomes too troublesome. Several large inertia governors have been designed with 2 equal inertia arms placed opposite and connected together by a link, as in the governor shown in Fig. 8.

Another way is to link the inertia arm to a separate arm carrying the eccentric, so placed as to balance the effect of gravity between the 2 masses, and also to hang the eccentric so as to give constant lead to the inlet steam valve from quarter load to full load. But at best such governors can be balanced only approximately. Most engines designed to run at speeds between 125 and 175 or 200 are therefore provided with some type of balanced centrifugal governor to overcome this.

The possibilities of the inertia governor as a substitute for the fly-ball governor have received little attention. Extreme quickness, with great stability and strength, can be obtained in vertical-spindle governors designed on the lines of the inertia shaft governor. The inertia arms are made in duplicate, pivoted opposite each other, cross-connected by a link, and provided with one spring for each arm. The result is a governor with exact running balance, inertia-governor quickness, and strength far beyond that of a fly-ball governor of usual type. The inertia weights are conveniently extended clear around the circle into ring form, made heavier on one side than on the other, so as to throw the center of gravity of the arm to the desired point with respect to pivot and shaft centers. With a polished cylindrical guard or housing over the weights and springs, a very neat-looking governor is produced. The drive of such a governor should be by gears instead of belt, so that the full benefit of exact and quick action can be obtained.

Heating Station Operation*

BOILERS AND GENERAL OPERATING CONDITIONS

IT was decided to take up just 2 subjects in the first report and endeavor to cover these subjects in a rather broad and comprehensive manner.

The subjects taken up under this report were:

1. Boilers.
2. General Operation Conditions.

Under the subject of boilers the following subjects were discussed:

1. Rating and Capacity.
2. Relation of Capacity to Efficiency.
3. Relation of CO_2 to Efficiency.
4. Water Purification.

It is considered good practice today to operate boilers at a high overload. Cases are on record where 200 per cent of load is often developed for a considerable time, and for a short time 300 per cent of load is being developed. It has been found in large stations to be more economical to operate boilers at high capacity and pay consequent high maintenance charge than operate boilers at low capacity and pay interest on the larger investment. In a heating plant where large steam capacity is required during the heating season, it would be considered, as a general rule, better policy to operate the boilers at a high overload than to install more boiler equipment and operate each unit at a less capacity.

E. C. Fisher, Vice President and General Manager of the Wickes Boiler Co., states in a letter to the Committee that condensing, in diagrammatic form, the chart Fig. 1 will give a sufficient detail for a fairly practical measurement, the requisites which control in a large measure the driving of boilers to a high rate of evaporation.

Heat transmission in boilers varies as the square root of the difference in temperature on the water side and the gas side. This is the theory expounded by W. J. M. Rankine. It is accepted by scientists generally as true. It is believed by many to control the whole problem of heat transfer.

There are 2 important steps necessary when considering the combustion side of the problem:

1. Burning sufficient fuel to obtain a volume of gas sufficient to bring about the capacity sought for.
2. The obtaining of complete combustion of that fuel, resulting in a flue gas analysis within the limits set forth.

The variables controlling furnace performance are, of course:

1. Furnace of sufficient volume to admit of complete admixture of gas with air and chemical union.
2. Grate surface of sufficient area.
3. Proper thickness of fire.
4. Proper draft over the fire to obtain and maintain the necessary rate of combustion to consume sufficient fuel per minute to deliver to the boiler gases within the limits of the composition named.

These conditions properly controlled, any sought for capacity, insofar as the furnace is concerned, may be obtained.

A study, by test, of the furnaces in your plant, to find the most economical adjustment, is therefore, advisable; if considering a new plant, a careful study of all the conditions prevailing is essential before making a choice of furnaces, if high rates of driving are sought for.

Transmission of heat from gas across steam boiler surface into the water on the other side takes place in 2 fundamentally different ways:

1. By direct radiation from the incandescent fuel, the flame and the hot gases.
2. By convection and conduction, or by the character of the action of the hot gases in the path of the flow, the nature of the metal boundary and the character of the water on the other side of the boundary.

*Abstract of the Station Operating Committee of the N. D. H. A.

The diagram, Fig. 2, is that published in "Modern Steam Boilers," by Rowan, on the results of M. J. Hirsch's experience:

The curve brings out clearly how rapid the transfer of heat from water to gas is during the period of high temperature gas and how slow the transfer is during the period of low temperature gas; how it is essential that the low temperature gases be utilized and not be released to the chimney at a temperature too high above the steam for the sake of driving our heating surface at a high rate of evaporation. If we do release these gases at high temperature a very severe falling off in efficiency results.

A steam boiler installed for high rates of driving must have a rapid, uniform and pre-determined circulation of water. A scrubbing action must be established on the water side so that as rapidly as the steam globules are formed they may be swept away and replaced by rapidly moving water. Steam must not be allowed to accumulate on the gas swept surface. The specific heat of steam, being only approximately one-half that of water, precludes its accumulation at a point where high temperature gases bathe the heating surface. The steam must be replaced by the water as quickly as the steam is formed, so that it is the water presenting itself to the hot gases for abstraction of the heat from the gases and

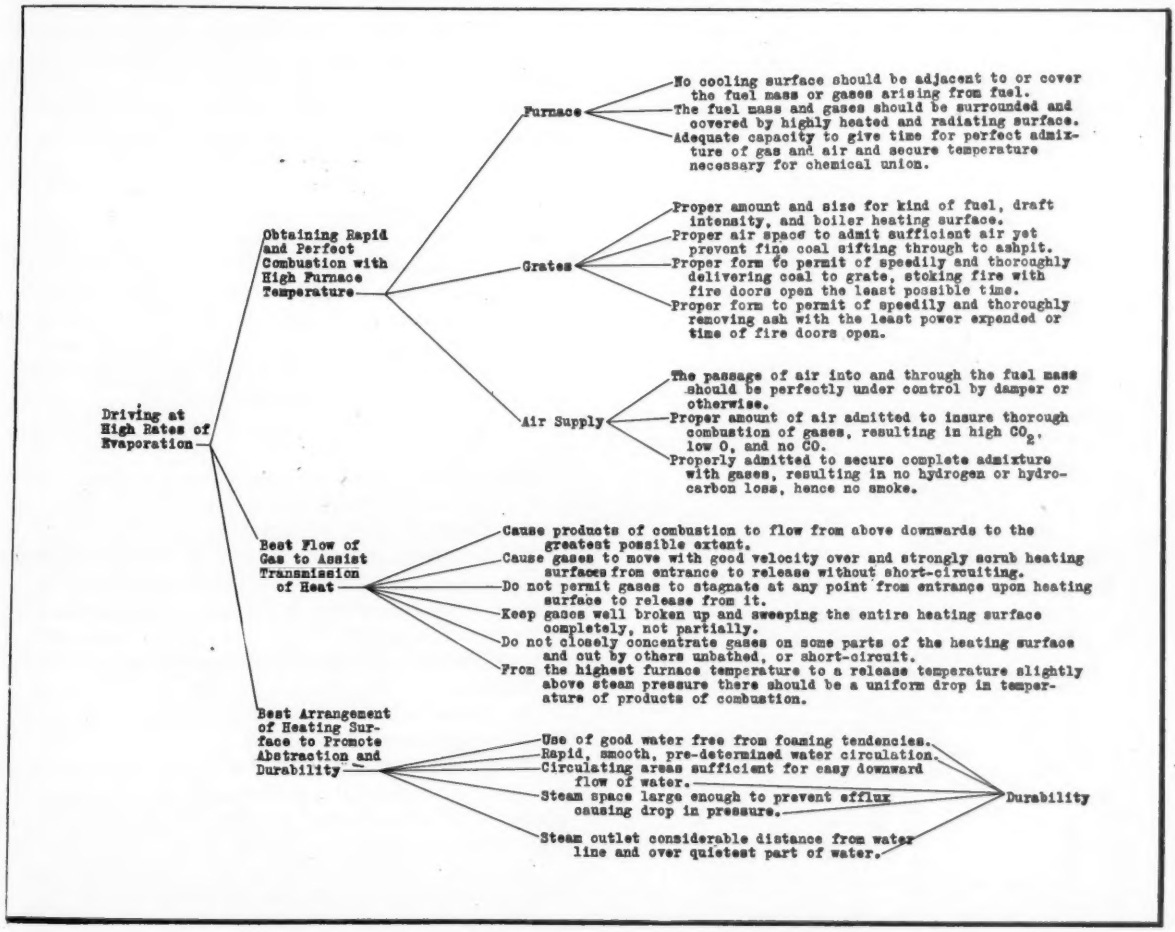

Driving at High Rates of Evaporation
Obtaining Rapid and Perfect Combustion with High Furnace Temperature
Furnace
No cooling surface should be adjacent to or cover the fuel mass or gases arising from fuel.
The fuel mass and gases should be surrounded and covered by highly heated and radiating surface.
Adequate capacity to give time for perfect admixture of gas and air and secure temperature necessary for chemical union.
Grates
Proper amount and size for kind of fuel, draft intensity, and boiler heating surface.
Proper air space to admit sufficient air yet prevent fine coal sifting through to ashpit.
Proper form to permit of speedily and thoroughly delivering coal to grate, stoking fire with fire doors open the least possible time.
Proper form to permit of speedily and thoroughly removing ash with the least power expended or time of fire doors open.
Air Supply
The passage of air into and through the fuel mass should be perfectly under control by damper or otherwise.
Proper amount of air admitted to insure thorough combustion of gases, resulting in high CO_2, low O, and no CO.
Properly admitted to secure complete admixture with gases, resulting in no hydrogen or hydrocarbon loss, hence no smoke.
Best Flow of Gas to Assist Transmission of Heat
Cause products of combustion to flow from above downwards to the greatest possible extent.
Cause gases to move with good velocity over and strongly scrub heating surfaces from entrance to release without short-circuiting.
Do not permit gases to stagnate at any point from entrance upon heating surface to release from it.
Keep gases well broken up and sweeping the entire heating surface completely, not partially.
Do not closely concentrate gases on some parts of the heating surface and cut by others unbathed, or short-circuit.
From the highest furnace temperature to a release temperature slightly above steam pressure there should be a uniform drop in temperature of products of combustion.
Best Arrangement of Heating Surface to Promote Abstraction and Durability
Use of good water free from foaming tendencies.
Rapid, smooth, pre-determined water circulation.
Circulating areas sufficient for easy downward flow of water.
Steam space large enough to prevent efflux causing drop in pressure.
Steam outlet considerable distance from water line and over quietest part of water.
Durability

FIG. 1. REQUISITES WHICH CONTROL DRIVING OF BOILERS

Because of the varying shapes and forms of boilers upon the market, because of varying cross-sectional areas of gas passages, because of different volumes in settings and different modes of gas travel, every boiler has its individual characteristic in its power to promote heat transmission.

The results of tests seem to indicate clearly that there is a great deal to be gained by paying close attention to the manner of the flow of gases over the heating surface if high transmission of heat to the water is to be obtained.

It must be clear that there is a close relation between the term efficiency and the rate of driving.

not steam, if high convection and conduction are sought for and durability is expected.

The principle of keeping the boiler heating surface free from soot, scale and oil is well understood and has been accepted as necessary for many years; yet the boiler troubles of today can usually be attributed to some of these old and recognized causes. These troubles become of double importance in considering the durability of the structure for high rates of driving. Care must be taken to see that the water has a close approximation to purity if forcing is to be carried on. An excess of carbonate of soda, caustic soda, sodium chloride or any other chemical which increases the density of the water

in the boiler will cause violent foaming in the boiler. When foaming occurs, unequal expansion and contraction results and failure of the heating surface in some parts of the boiler is unavoidable.

To sum up, it may be seen that the question of driving steam boilers to a high rate of evaporation, within practical limits, is one of combustion; is one of a proper flow of the gases over the heating surface; is one of a properly designed boiler to provide for a rapid, smooth, predetermined circulation; is one of the character of the water used in the boiler.

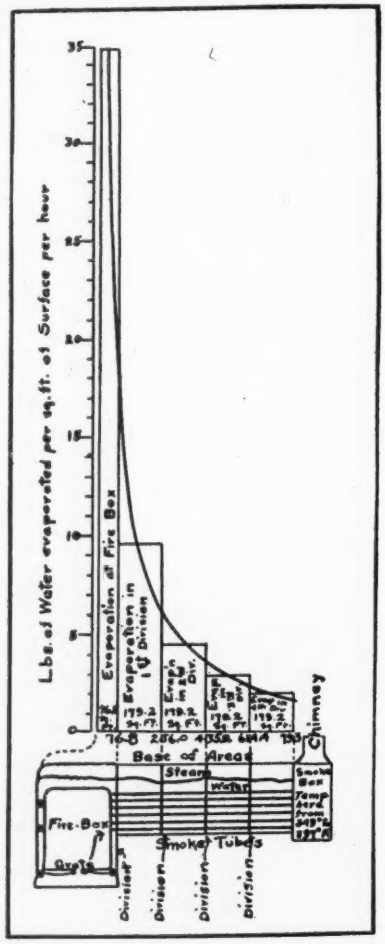


FIG. 2. CURVE SHOWING DIVISION OF WORK DONE IN SECTIONS OF LOCOMOTIVE TYPE BOILER

D. S. Jacobus, of Babcock & Wilcox Boiler Co., states in a letter that whether the plant be hot water or steam apparently makes little difference as to the general conditions affecting the boiler capacity required.

Apparently, with eastern coal or coal with low ash content it is possible to operate boilers at 200 per cent overload for a considerable period of time. With coals of a quality such as is mined in Illinois and Indiana, 200 per cent of load may be considered as an extreme capacity. With western fuels, such as lignite, 150 per cent of load is probably the extreme which should be considered. With oil burning furnaces and installations, 300 per cent of load should be considered as the extreme capacity.

In designing the boiler installation for 200 per cent of load, the extreme capacity, it will probably be found good practice, if not the best practice, to design a boiler to operate most economically at 125 to 150 per cent of load. A condition of this kind requires larger combustion chambers than would be the practice if the boilers were designed to operate most efficiently at a full load. It would also require somewhat larger gas passages and also a larger stoker equipment.

The only way to arrive at a satisfactory solution of the capacity problem, is to consider a given central heating plant and take into account the actual steam that must be generated. If the plant is used simply for heating, it must lie idle for the greater part of the time, and for this reason alone it would pay to run the boilers at a high capacity to reduce the capital investment. Again, in such a plant the boilers are called upon to produce their maximum load only during the few days when the weather is the coldest, and taking everything into consideration it will no doubt pay to run the boilers at as high a capacity as can be accomplished without involving operating difficulties.

With stokers designed especially for operating at high loads, the combined efficiency of the boilers and stokers may be just as high at a load of, say, 150 to 200 per cent of rating as at lower loads. With chain grate stokers proportioned for running at high ratings we would expect no appreciable falling off in the economy up to, say, 175 per cent of rating.

Relation of Capacity to Efficiency

Joseph Harrington, in a paper, states that:

1. Furnace efficiency is the controlling factor in the combined efficiency of the furnace and boiler.
2. A heat balance on the coal as fired is necessary for the complete understanding of efficiency loss.
3. Furnace efficiency is the key to high boiler room economy.
4. Furnace efficiency is independent of the rate of combustion.
5. A horizontal combined efficiency curve is possible of approximate attainment.

The combustion of carbon with the amount of air necessary to supply the correct amount of oxygen for perfect combustion would produce a gas having by volume 20.91 per cent CO_2 and 79.09 per cent of N and a temperature of over 4800 deg. F. This same combustion, with double the amount of air required, would produce a gas having about 10.5 per cent CO_2 at a temperature of 2500 deg.

In practice, it is not possible to secure complete combustion with the theoretical amount of air. The amount of excess, which must be admitted for complete combustion, depends upon the size and proportions of the furnace. The furnace design in turn depends upon the percentage of volatile combustible in the fuel and the rate of combustion.

The fact may be established for a particular set of conditions that 11 per cent of CO_2 gives the highest efficiency, whereas for a different set of conditions 14 per cent might represent best results. An attempt to operate the first unit at 14 per cent CO_2 instead of 11 per cent would result in incomplete combustion, due to the fact that the furnace does not provide sufficient volume

and mixing effect to burn all the combustible with the amount of air present. On the other hand, the second unit operated at 11 per cent CO_2 would suffer in efficiency, because more than the necessary amount of air for complete combustion was being admitted. In this particular case the unit, which was capable of giving complete combustion with 14 per cent CO_2 would give higher efficiency than the unit which could not properly exceed 11 per cent. In each case, however, the gas analysis should be kept as closely as possible to the predetermined point of highest efficiency.

A plant of first-class design and equipped throughout with the best instruments does not necessarily give good results, and it is often the case that a plant of inferior equipment gives superior results on account of the greater degree of intelligence and watchfulness in its operation.

The effect that moisture in the coal has on furnace efficiency is in inverse proportion. A curve is shown in Fig. 3 which gives us a rather comprehensive idea on this subect. The more moisture in the coal, of course, the more heat required to evaporate this moisture. This curve is based on the 15,000 B.t.u. coal without moisture, and it is shown that with 10 per cent moisture in this coal we would get 13,500 heat units available for useful work.

For a proper appreciation of the disposition of the heat contained in a pound of fuel, the only logical way to base this analysis is on the heat contained in the fuel as it is actually fired, rather than upon the basis of either dry coal or combustible, which, after all, are theoretical conditions and are never attained in actual practice.

What the engineer wants to know is, how the heat contained in the actual coal he is firing is disposed of; as the moisture contained in the coal has an influence on the efficiency of the entire process, it must be taken into consideration in an accurate analysis.

The design of the furnace to effect the necessary mixing of air varies widely with different fuels and drafts and rates of combustion and in the absence of any means for determining this mathematically, it appears still to remain largely a question of experience.

Outside of the question of a high versus a low efficiency, the matter of a horizontal efficiency is of greatest importance. There is no single question entering into the production of a satisfactory plant efficiency that is anything like the importance of a uniform efficiency curve. In practically all power plants, the load is variable, and in the case of street railway and illuminating companies, the load is extremely uneven with sudden and high peaks, and in many cases, unexpected peaks.

Water Purification

THE COMMITTEE has asked Frank Vater, of the Power Plant Specialty Co., Chicago, to prepare a paper. Mr. Vater has discussed the subject from an unbiased standpoint, giving some actual results which have been obtained in operation of water softening plants.

He said in part:

As a means of reducing the cost of producing steam, an efficient water softening plant, properly installed and properly operated, will pay dividends. You cannot cool down, heat up and place in service again a 250-hp. boiler on less than 1½ tons of coal; other sizes cost proportionately the same. If cleaned every 6 weeks, or 8 times a year, this means 12 tons of coal per boiler wasted.

What does your turbining cost you? Seldom, if ever, where part of the boiler supply is raw water, can you turbine one lineal foot of 4-in. tube for less than ¼ cent per foot. This cost obtains where the makeup water used does not contain more than 15 gr. of incrusting matter per gallon, or one-half the quantity referred to above. This cost increases with an increase in the kind and quantity of scale-making matter contained in the water, until it reaches a cost of 1 cent per lineal foot of 4-in. tube.

In the central hot water circulating plant the problem broadens. If scale caused trouble in boiler tubes, sludge causes trouble in your heating system. If it can be removed from your boiler, it can be removed from your circulating water.

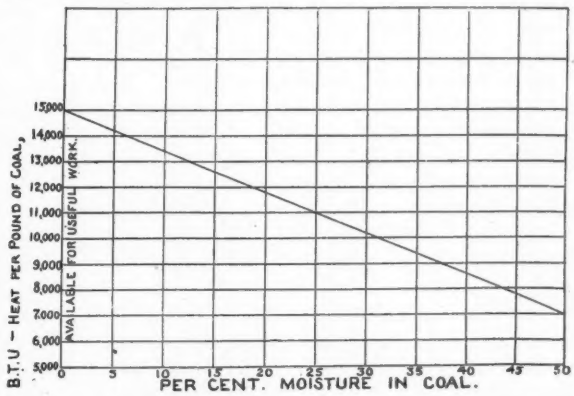


FIG. 3. INFLUENCE OF MOISTURE IN COAL ON EVAPORATIVE POWER OF FUEL

There is a correct method of ascertaining what a softening plant will do for you, and whether or not its installation is justified, it is purely a bookkeeping proposition.

There should be charged against the total cost of installation of the plant 10 per cent for interest and depreciation, the cost of chemical for treating the quantity of water that will be handled and the cost of labor required in its operation; there should be credited to the plant the present cost of boiler compound and ⅞ of the cost of turbining the tubes, also the cost of taking out and replacing burned tubes, and this will approximate $7.50 for each 4-in. by 18-ft. tube; there should be credited to the plant the saving in coal which continuous service to the boilers means and the saving in coal due to the fact that the maximum evaporative efficiency is obtained when the boiler is clean; there should be credited to the plant that sum of money saved by doing away with the replacement of service or radiator nipples, which have given down under the action of acids in the water.

There is one material benefit accompanying the installation of a water softener which is sometimes overlooked, and that is the ability it gives you to overload your boilers.

The measure of value to a plant in a water softening process is 2-fold; namely, how much of the incrust-

ing matter will the treatment remove? Second, what is the density of the water after treatment?

Basic Principles Absolutely Necessary

These are time, accurate chemical feed and perfect filtration. Time governs absolutely the capacity of a system, determines the cubic capacity or size of the tanks, governs the amount of precipitate thrown down by the chemical, and varies with the temperature of the water to be treated. Hence, on a given time limit, better work will be obtained in summer than in winter.

Constant temperature means a constant result, influences the quantity of excess chemical required, this excess being less under 8 hours' time than under 4, influences the attention required in operating a system and hence the labor cost of operation and influences the frequency of blowing down.

Accurate chemical feed, with *right time*, absolutely controls the result. It controls the labor or attention necessary to efficient operation, the chemical cost of obtaining results and the problem of foaming, and influences the frequency of blowing down.

Perfect filtration influences the cost of maintenance and hence the cost of operation; influences the problem of foaming, as sludge in sufficient quantity will cause foaming; controls the trouble with boiler room auxiliaries caused by sludge, prevents the use of a coagulant such as sulphate of alumina, which not only increases cost but is detrimental, and reduces the frequency of blowing down.

No water softener is capable of being worked above its rated capacity without reducing its efficiency. Don't, therefore, buy on the basis of the boiler horsepower in your plant. Buy on a rating of gallons per hour capacity, bearing in mind you can't overload it and obtain all it should give you.

General Operating Conditions

In a steam plant, the initial pressure required on the pipe line or, in other words, the pressure at the station end of the pipe line is dependent on conditions existing in the pipe line and in the consumers' equipment. The insulation of the pipe line, the size of the mains, the style of the system, whether return or non-return, all affect the initial pressure required at the station. Ordinarily it is most economical to operate the exhaust steam heating line with as low a pressure as possible. The determining factor in this respect is that we must have a sufficient pressure at the consumers' service to fill properly the consumers' equipment with steam. Ordinarily, 1 lb. gage pressure at the service entrance is sufficient to do this, and if this pressure is not sufficient to fulfill the requirements, the condition of the consumers' equipment should be investigated and the fault remedied, rather than endeavor to carry a higher pressure on the pipe line to overcome the difficulty.

The insulation of the pipe line affects the pressure, and as we all know, materially affects the economy of the heating plant. The size of the mains also affects the initial pressure owing to the friction in the pipe line. It is almost impossible to operate economically unless the pipe line is properly built and designed and unless it fulfills the conditions under which it must work. As a general rule, the committee recommends that the initial pressure on a steam heating system be kept as low as possible. It can be definitely stated that within certain limits, the net earnings of a heating system are inversely proportional to the initial pressure on the heating main.

In a hot water system, the heat is transmitted to the consumer by means of circulating water. This water takes on heat at the station and emits heat in the consumers' radiator. The 3 vital points, therefore, in operating a hot water plant are as follows: Circulation of the water, reheating of the water, cooling of the water.

The first item; namely, the circulation of the water, is affected, first, by the pipe line conditions and second, by the circulating devices which propel the water. Radiation losses in the pipe line affect the station operating, in that they allow a greater difference in temperature between the incoming and outgoing lines. This means that a higher temperature will be required on the outgoing lines in order to give the required temperature at the consumers' radiation, and this, of course, means a more expensive operation owing to the higher temperature required in the outgoing water. Friction loss in the pipe line increases the differential pressure at the station and consequently requires greater pumping power. The grade and contour of the pipe line also affect the station operating. Owing to the laws of gravity, hot water or water heating tends to rise and cold water or water cooling tends to fall. This we know from the circulation of a gravity hot water heating system, and if, therefore, the contour of the pipe line is such that we have occasion to oppose the laws of gravity, we will add considerable more work to our circulating pumps and consequently will increase our operating costs.

We are in the heating business to make money out of it. As a rule, we are obliged to go to the accounting department for information relative to what we are doing as to amount of coal we burn; the amount of money spent for labor, supplies, etc.; all of which is absolutely wrong. The operating engineer should know all of this and he should also be able to have the following information at all times:

Coal burned under each boiler.

Water evaporated or heated by each boiler.

Furnace conditions such as draft and gas analysis.

The committee has investigated several plants that have recently started keeping accurate costs; in every case, the saving has been sufficient to pay for the instruments and apparatus purchased in from 1 to 5 months.

Nearly every employe is willing to improve his record if he only knew how and had some way of telling what he is doing; furnish the way for him to tell.

A point of interest which has come under the notice of the committee is the lack of information as to the cost per thousand pounds of steam under various operating conditions in a given plant. There is no set rule for figuring costs, nor standard of arriving at them.

Your committee recommends, therefore, that in order to get economical operating results, it is necessary for you to know what each piece of apparatus in the station is doing, what it can do and what it would do under various conditions; then line up the operation so as to get the best results from each piece of apparatus.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Practical Electrical Engineering

CABLE SPLICING AND HANGING. BY NORMAN G. MEADE

CONNECTIONS to large generators and motors are usually permanent, and they should be made in the best workmanlike manner to prevent more than ordinary deterioration. It is best to run all cables beneath the engine room floor to the switchboard and

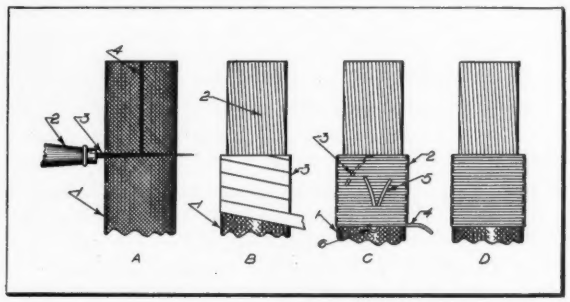


FIG. 1. FINISHING CABLE ENDS

where the cables are subjected to much moisture or where exposed to the weather, lead-covered cables are preferable.

All cable ends where attached to the machine or to the switchboard should be finished as shown in Fig. 1.

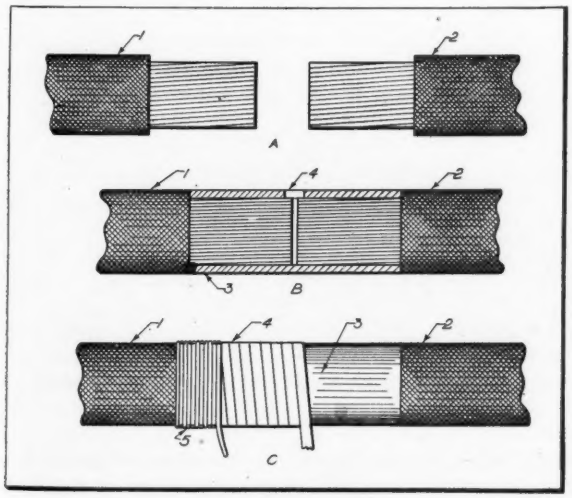


FIG. 2. CABLE SPLICED WITH SLEEVE

Rubber and braided insulation, which should be used, peels readily and the strands forming the conductor are tinned. The first operation is shown at A in the figure. With the knife, 2, cut through the insulation, 1, all around the cable as at 3, then cut a vertical slit, 4, when the covering can be easily stripped. Next, proceed as shown at B, in which 1 is the insulation, 2 the conductors and 3 a layer of tape which should cover about 3 in. of the cable.

Over the tape wrap tightly a layer of heavy cord, as shown at C, in which 1 is the cable insulation, 2 the cord, 3 the first end of the cord turned under the convolutions, 4 the last end of the cord, 5 a piece of cord, with loop, 6, under a few turns of the cord winding. Pass end, 4, through loop, 6, then pull out the cord by grasping ends, 5. This will draw end 4 through under several turns and out, where it should be cut off flush

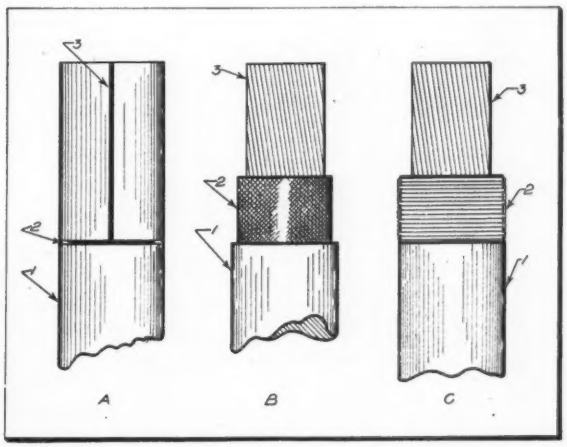


FIG. 3. PREPARING ENDS OF LEAD-COVERED CABLE

with the surface. The binding should then be given a thorough coating of asphaltum, when the finished cable end will have the appearance shown at D.

Splicing a cable of any considerable size should be done by means of a sleeve, as shown in Fig. 2. Prepare the ends to be spliced as shown by 1 and 2 at A, and insert them into a heavy brass sleeve, 3, in which a hole, 4, is bored as shown at B. The inside of the sleeve should be tinned by heating it, then applying flux and solder. Apply flux to band ends of cable, place in sleeve, apply flame of the gasoline torch to it and when sufficiently heated, feed wire solder through hole 4, occasionally applying some flux through the hole.

A good soldering flux can be made from 6 parts saturated solution of zinc chloride, 4 parts alcohol and 1 part glycerin. The zinc chloride is prepared by

dissolving strips of pure sheet zinc in hydrochloric acid until the liquid no longer attacks the metal. The solution should be kept in a lead or glass receptacle.

When cooled, the joint should be thoroughly wiped, sandpapered and a double layer of rubber tape applied, over which a layer of heavy cord extending about an inch past each end of the joint is wrapped, the whole being given a coating of asphaltum. The process of wrapping the joint is shown at C, in which 1 and 2 are the cable ends, 3 the sleeves, 4 tape, and 5 the cord.

Lead-Covered Cable Splicing

Reference to Fig. 3 will show the manner of preparing the ends of lead-covered cables. Extreme care has to be taken to prevent moisture from getting under the lead sheath and to prevent the conductor and the

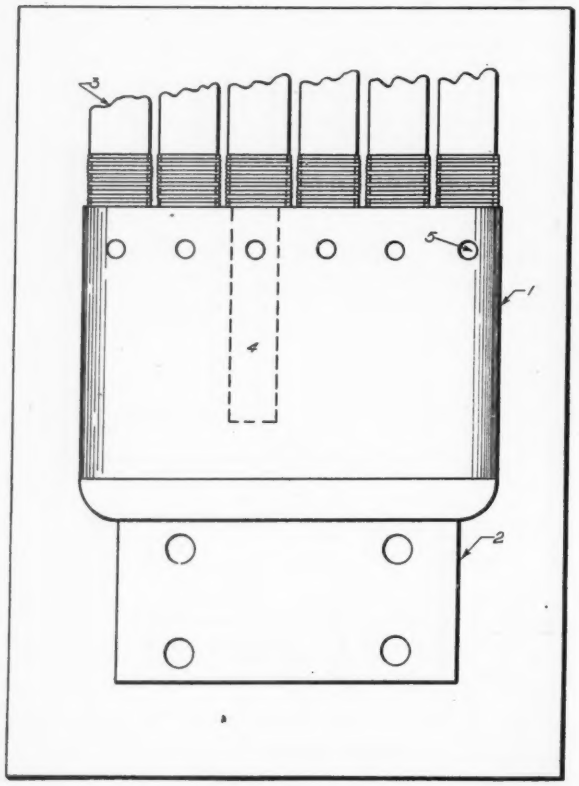


FIG. 4. CABLE LUG

sheath from making contact. With a knife and a mallet, cut the lead sheath, 1, as shown at 2 and 3, taking care not to cut the insulation beneath, then strip the lead. The insulation should then be cut away to about 2 in. from the lead, 1, as shown by 2 at B, leaving the exposed conductor, 3. Next apply pitch or melted resin at the termination of the lead sheath and cover the exposed insulation with a wrapping of tape and cord painted with asphaltum, as shown at C.

The splicing of lead cables requires the same operations as ordinary cables, with the addition of a lead sleeve over the tape wrappings. The sleeve is made integral with the sheath at each end by a wiped joint. As this requires considerable skill, it is well to employ a plumber to make the wiped joints.

Figure 4 shows a large cable lug, 1, with connection plate, 2; 6 cables, one shown at 3, are soldered into the lug, the dotted lines at 4 showing how the cable end extends into the lug. Holes are drilled in the side of the lug extending into the hole for receiving the

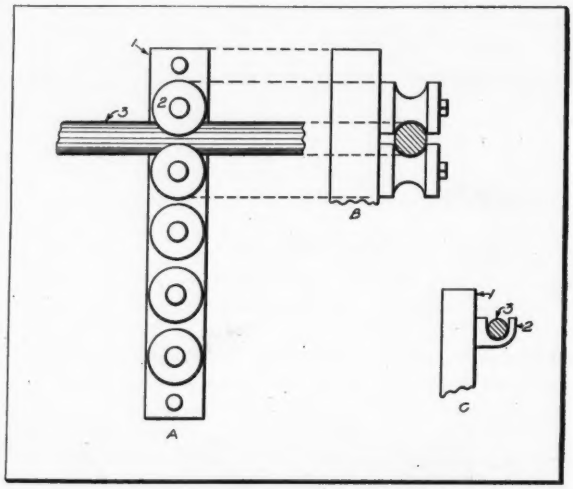


FIG. 5. CABLE SUPPORT

cable, as shown at 5. These holes are to facilitate soldering. Before putting the cable ends into the lug, the holes should be tinned in the same manner as the sleeve already described. After this is done, place the lug in a convenient position for working with cable holes upward; pour some flux into each hole, insert the cables

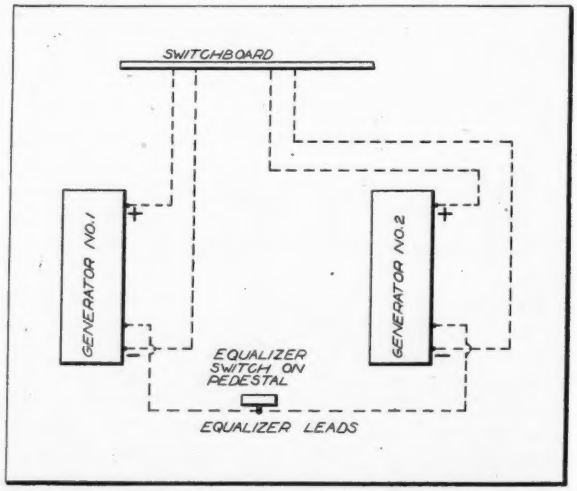


FIG. 6. GENERATOR CONNECTIONS, SHOWING LOCATION OF EQUALIZER SWITCH

and apply the gasoline torch flame until the lug is sufficiently hot, then feed wire solder through the holes on the side until full.

Cable Supports

Rigid supports placed about 4 ft. apart must be provided to support the cables between the generator and the switchboard. For ordinary cables, insulators

must be provided; but lead-covered can be supported by hooks, as shown at C, Fig. 5, in which 2 is the hook attached to a wood backing, 1, and supporting the cable, 3. For ordinary cables, a good and simple rack is shown at A and B, Fig. 5. It consists of a 2 by 4 wood strip to which are attached, by lag screws, the porcelain insulators, 2, which support the cable, 3.

Where there are 2 or more generators operating in parallel, especially where the switchboard is located at some distance from them, a saving in cable can be secured by placing the equalizing switch on a pedestal between the generators, as shown in Fig. 6.

New Adjustable Speed Induction Motor

CONVENIENT METHOD OF OBTAINING SPEED ADJUSTMENT OF POLYPHASE INDUCTION MOTORS

IN regard to speed, the characteristics of the ordinary polyphase induction motor are similar to those of the direct-current shunt wound machine; that is to say, it is essentially a single speed motor, in which that single speed is approximately synchronous speed. This motor is well adapted to the driving of machinery requiring a constant rate of rotation, but is far from being suited for any service which requires adjustable speeds over a considerable speed range. Various schemes have been tried out to give the ordinary polyphase induction motor a variable speed, one of these being to provide it with wound secondaries closed on adjustable rheostats. While this method of control resulted in a wide range of speed, at the same time it had the serious disadvantage of lowering the efficiency of the motor. Multiple-pole groups in the primary winding also permit of one or 2 or 3 adjustments of speed, but the plan has never been adopted to any extent.

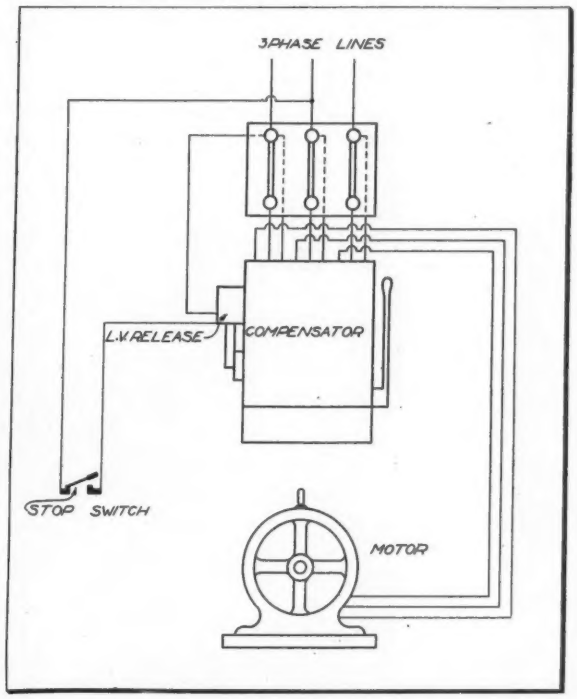
Recently, there has been developed a motor which has the advantage of maintaining a fairly high efficiency at all working speeds. The secondary element of this new motor is as usual the rotor; but the primary element, instead of being a stator and receiving its current from the line through fixed connections, is mounted on hollow ball bearings and rotates, so that the machine has 2 rotors.

The primary winding receives its current through slip rings, 3 rings being sufficient for one set of rotating poles; but as the machine is made to operate on either 2 or 4 poles in the primary winding, 6 slip rings are used. With the primary element at rest, this would permit running at 1500 r.p.m., or 3000 r.p.m. at 50-cycle, 3-phase current. The primary element is, however, built within the squirrel cage secondary of a second and auxiliary squirrel cage induction motor, the primary element of which is a stator arranged to provide either 6, 8, 12 or 16 poles. This auxiliary 3-phase motor can be run either forward or backward, thus changing the synchronous speed of the main or internal motor from 1000 to 2000 r.p.m. on the low main speed, or from 2500 to 3500 r.p.m. on the high main speed, thus affording a total range from 1000 to 3500 r.p.m. in 18 steps, with an efficiency of about 90 per cent in a motor delivering from 60 to 225 kw.

The expense of telescoping 2 individual induction motors into 1 is not likely to be justified in small machines; but in the case of large motors, the importance of securing adjustability in speed may occasionally warrant the added complexity of structure.

A Convenient Stop-Switch

AUTO starters, or compensators, are now quite universally used for the control of the larger sizes of multi-phase squirrel cage induction motors. The full value of the low voltage release used on these compensators is frequently not fully realized since this attachment may easily be arranged to serve as a convenient means of stopping the motor. In the circuit of the no



METHOD OF CONNECTING STOP SWITCH TO LOW VOLTAGE RELEASE

voltage release and located at a point where it will be most convenient to stop the motor, is installed a small single-pole single-throw knife switch. This arrangement is, however, not limited to the use of a single switch but allows any number to be connected in series and located where desired, thus extending the range of its usefulness. Opening any one of these switches will cause the compensator to move to the off position, thereby stopping the motor. This scheme may be applied as a safety device if for no other use. GORDON FOX.

DON'T PLASTER holes in a boiler setting, as the plaster will not stick—calk them. One method is to use a mixture of fire clay with dry cotton waste. Pull the waste apart and thoroughly work in into the clay so that every fiber will be covered with clay. Then use a sharp stick to tamp the clay into the cracks. It will stick. A short time will enable you to do considerable of this work. It may be done while the boiler is in operation.—Coal Facts.

Electric Locomotives for Piedmont & Northern Lines

THE Piedmont & Northern Lines, Charlotte, N. C., have recently placed in commission 6 new 1500-v., d.-c. electric locomotives on the Greenville, Spartanburg & Anderson division of their system. These locomotives weigh 63½ tons, with all the weight on drivers, have the box type of cab extending nearly the entire length of the underframe and are designed for heavy freight service. At the normal rating of the 4 GE-212 motors, with which each locomotive is equipped, operated on 1500 volts 2 in series, they will develop a tractive effort of 17,500 lb. and a speed of 21 mi. an hour. The locomotives will handle trains of 800 to 1000 tons gross weight.

The Piedmont & Northern Lines comprise 2 main divisions, which, when entirely completed, will embrace 280 mi. of track for limited and local passenger, express and heavy freight service. One division, operated by the Piedmont Traction Co., extends from Charlotte, N. C., to King's Mountain, N. C. The other division, operated by the Greenville, Spartanburg & Anderson Traction Co., extends from Greenwood through Greenville to Spartanburg, S. C., and joins the northern division at King's Mountain.

All these lines operate on 1500 volts d.c. Energy is purchased from the Southern Power Co. and is delivered from the transmission lines to 2 substations for the Piedmont Traction Co., one in Charlotte and the other in Gastonia. On the southern division of the road there are 4 substations, one 3 mi. south of Spartanburg, one at Greenville, one at Belton and one at Downs, which is 3 mi. out of Greenwood. The roads have a heavy freight traffic and transport great quantities of cotton from shipping points to the various mills along the route, and in turn fabric from the mills to connecting stations for distribution to distant markets.

The new locomotives were designed and built by the General Electric Co. The cab is of the all-steel box type and extends nearly the whole length of the underframing. Outside platforms of suitable width are left at each end for the switchman to handle the trolley poles and are protected by side and end hand or guard rails. In the interior the cab is open throughout as far as is consistent with the apparatus located therein. While the operating mechanism is grouped in the central section, it is not located in a compartment separate from the engineer's operating cabs. Convenient passageways run along each side and connect with the operating positions in each end. The cab is built up of steel channels and angles and sheet steel plates properly braced and riveted together, and is entered through center doors at each end.

The underframe or backbone of the locomotive consists of 4 10-in. steel channels extending the entire length of the platform, properly tied together.

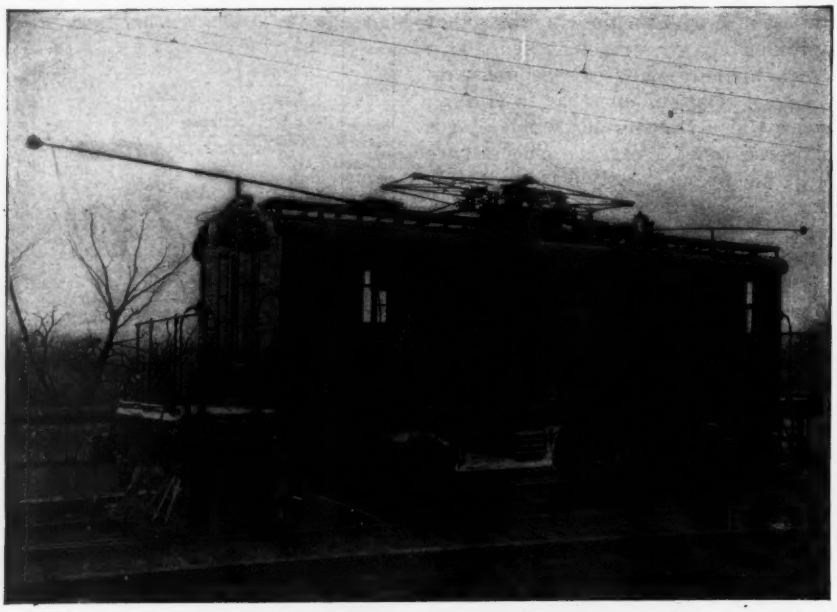


FIG. 1. 1500-V. ELECTRIC LOCOMOTIVE FOR THE PIEDMONT & NORTHERN LINES

The 2 4-wheel trucks are a swivel type, designed for heavy freight work. The side frames are built of heavy rolled bars for top and bottom members with cast steel pedestals. The bolster, or center transom, is bolted rigidly to the side frames, and the entire weight of the truck framing is supported on heavy semi-elliptic springs hung by links to the double side equalizer bars, which in turn rest on the journal boxes. The journal boxes are a standard design with MCB bronze bearings and wedges. The wheels are solid rolled steel, 36-in. diameter, with MCB treads and flanges. The axles are forged open hearth steel, 6-in. diameter between the wheels and with 5½ by 10-in. journals. The air brakes are the combined straight and automatic type. The brake shoes are inside hung, and the brake rigging is proportioned for a brake shoe pressure of 85 per cent

of the weight on the drivers with 50 lb. pressure in the brake cylinders. Hand brakes are provided to hold the engine in the yard in case of loss of air pressure in the brake cylinders.

Taking up the electric equipment, the locomotive is driven by 4 GE-212 F, 600-1200-v. box frame commutating pole motors, insulated for operation on 1500 v. Each motor is geared to an axle. All the axles are therefore driving axles. A forged pinion is mounted on each armature shaft and meshes into a corresponding solid steel gear mounted on the axle. The gear ratio is 65 to 18 teeth, making 3.61 gear reduction. The continuous capacity of each motor is 200 amp. under forced ventilation, and 269 amp. at the one hour rating. For the complete equipment of 4 motors on a locomotive, this is equivalent to a continuously sustained tractive effort of 11,200 lb. at the rail head.

The GE-212 motor is enclosed and is designed especially for locomotive service. Through the method of forced ventilation employed, air is circulated over the armature and field coils, over and through the commutator, through longitudinal holes in the armature core, and thence exhausted through openings in the bearing head.

so as to afford ready and complete access to all parts for inspection, cleaning, adjustment or repair.

The blower set for ventilating the motors has a capacity of 2000 cu. ft. per min. and is driven by a series-wound motor of the railway type. Air is taken from the exterior through a suction box with side louvres underneath the platform at the center. Current at 600 volts for the operation of the blower, and also the air compressors, the contactors and the lights, is furnished from a 2/5 tap taken from the dynamotor.

The air compressors are 2-stage motor-driven compressors, Type CP-30, and have a total piston displacement of 70 cu. ft. per min. when pumping against a tank pressure of 90 lb. per sq. in. Air is taken in from the interior of the cab through strainer screens and is delivered into the 2 air reservoirs, connected in series, thereby affording an opportunity for radiation of heat and condensation of moisture before entering the air brake cylinders.

Current is collected by an overhead US-13 pantograph trolley, which is pneumatically controlled and can be put into service from either engineer's station by a manually-operated valve. On some of the local lines which form the system, the overhead construction is not

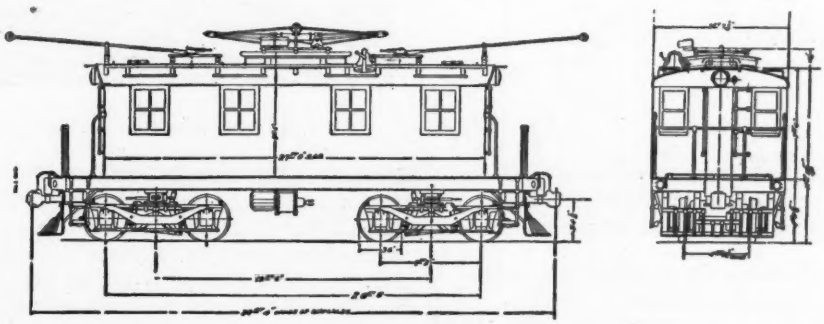


FIG. 2. OUTLINE OF LOCOMOTIVE

The control equipment is the Sprague-General Electric Type M multiple unit control, arranged to operate the 4 motors in series and series-parallel connections. The pairs of motors with their respective resistances are all connected in series on the first point of the controller. The resistance is varied through 6 points and finally short-circuited on the seventh or running point. The pairs of motors are then operated similarly in series-parallel and all resistance is cut out on the twelfth point, which is the full speed running point. This provides control connections with 7 steps in series and 5 steps in series-parallel. The transition between series and series parallel is effected without opening the motor circuit, and there is no appreciable reduction in tractive effort during the change. This smooth transition between control points permits operating the motors close to the slipping point of the wheels throughout the entire range of acceleration without sudden fluctuations of tractive effort. Two switches are provided for cutting out either pair of motors, so that the locomotive can then be operated with one pair of motors in the usual manner.

One of the new and distinctive features for a locomotive of this type is the convenient manner in which the apparatus is arranged in the central section of the cab

adapted for the pantagraph trolley, and in order to operate over such lines, the locomotives are equipped with pole type trolleys and trolley wheels. Some of those local lines are operated on 600 and in some cases as low as 500 v. d.c. A change-over switch is installed for cutting out the dynamotor while the locomotive is operating on low voltage circuits, so that in such cases the current for the auxiliary control and supply circuits is obtained direct from the trolley circuit. This change-over switch is protected by an automatic relay, which makes it impossible to connect 1500-volt trolley current to the auxiliary circuits of the locomotive.

Protection of the locomotive against short circuit is very complete. There is one main fuse for the trolley circuit, 2 fuses for protecting locally the circuits of the pairs of motors and smaller fuses for the auxiliary circuits. An aluminum cell lightning arrester is also installed in the cab.

AFTER A BRUSH has become too soft by long use, it may be cleaned and returned to its original rigidity by placing it for about 10 min. in ammonia, then taking out and leaving to dry in a warm place, but never in the sunshine.

Rjukan Hydro-Electric Power Station

NORWAY FALLS PRESENTS SOME IDEAL CONDITIONS FOR POWER DEVELOPMENT; TRANSPORTATION DIFFICULTIES A SERIOUS PROBLEM

IN THE beginning of the present century, a syndicate, under the direction of Dr. Eyde, civil engineer, obtained by purchase, the water rights and properties in Vestfjorddalen, Norway, which were connected

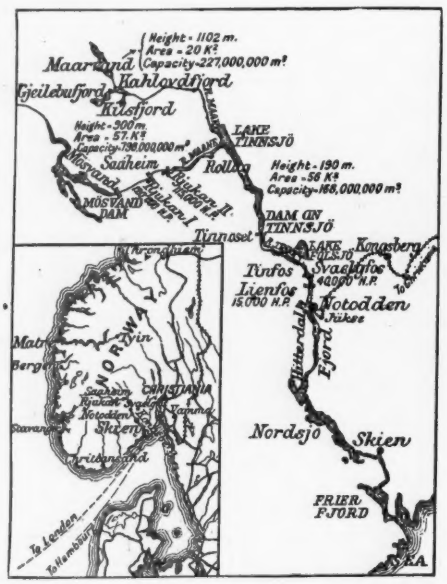


FIG. 1. MAP OF VESTFJORDDALEN, NORWAY, SHOWING SITUATION OF RJUKAN POWER DEVELOPMENT

with the Rjukan Fos and the neighboring rapids. It was felt that it would be necessary, however, before these could be utilized, to go to great expense with a view of transport. Otherwise, the conditions for a power station were nearly ideal, there being directly above the waterfall a large lake, the Mösvand, admirably suited for a storage regulation reservoir. The situation is shown in the map, Fig. 1.

The surface of Lake Mösvand lies about 2952 ft. above the level of the sea, its drainage area being about 564 sq. mi. From Lake Mösvand the River Maana descends in a distance of 19 mi., down to Lake Tinnsjö, the surface of which is about 623 ft. above the sea level.

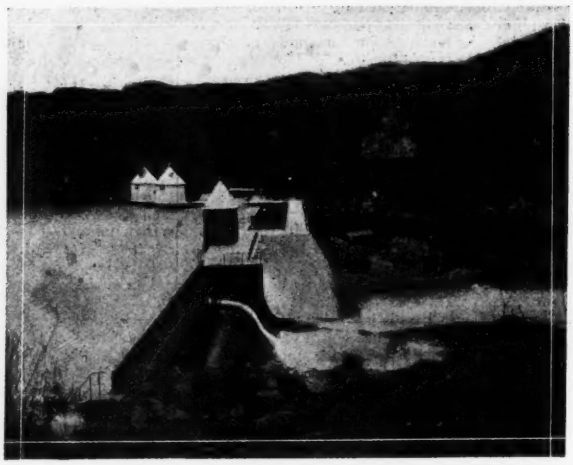


FIG. 2. THE MÖSVAND DAM FROM THE SOUTH

The entire fall from Mösvand to Tinnsjö is thus about 2328 ft., of which the Rjukan Fos itself represents a vertical fall of about 344 ft., and the rapids and waterfalls utilized in a length of about 6¼ mi. by the Rjukan Power Works, a total height of fall of about 1870 ft., the level of water in the basin of the intake at Skarsfos lying at a height of 2804 ft., and the tail-race of the Saaheim Power Station at a level of 931 ft. This height of fall has been utilized by 2 power stations; one at Vemork and the other at Saaheim, see Fig. 1.

The average quantity of water running per annum from Lake Mösvand amounts to about 53,000,000,000

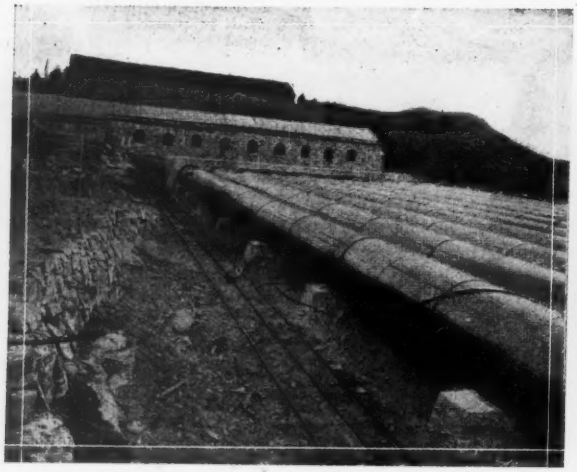


FIG. 3. UPPER END OF PIPE LINE

FIG. 4. OVERHEAD POWER MAINS

cu. ft. The flow in the River Maana is very variable. At the time of the high flood in the summer, when the snow is melting in the mountains, it may amount to 10,000 cu. ft. per second, whereas during the winter, when snow is falling, it may go down to about 44 cu. ft. per second. In order to utilize the water power existing in the falls of the River Maana, it was therefore necessary to retain in the Lake Mösvand, part of the water of the freshets and make use of these as a reserve during the period of low water.

The sawmills and wood pulp manufactories in the town of Skien, formed, in 1881, a union of mill owners, for the purpose of looking after the common interests of the works relative to the supply of water. In the year 1903 this union took action for a regulation of the Lake Mösvand. The works were commenced in the autumn of 1904, and were completed at the beginning of 1906. The joint-stock company, A/S Rjukan Fos, commenced, in the year 1907, the construction of the Rjukan Power Works, and decided at the same time to undertake a further regulation of the Mösvand, and during the years 1907-1909 the dam was rebuilt and heightened. On the completion of these works the regulated water flow in the River Maana amounted to 1692 cu. ft. per second.

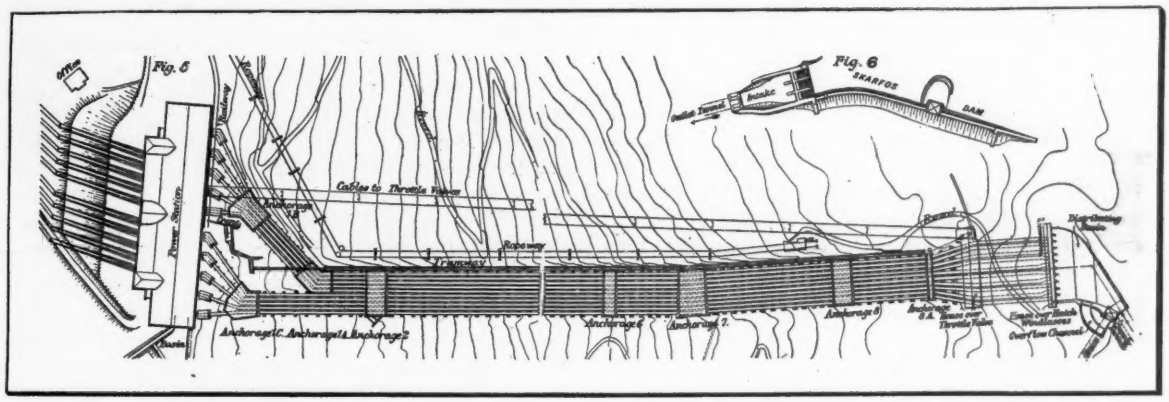


FIG. 5. PLAN OF PIPE LINE

FIG. 6. ARRANGEMENT OF SKARFOS DAM AND POWER HOUSE

The Regulation of Lake Mösvand

The original level of the Lake Mösvand was 2960 ft., or thereabout, above sea level, and the area of the water at this level was about 110 sq. mi. The first regulation was executed between the levels 2957 ft. and 2990 ft. By the enlargement of the dam the maximum water-level was raised, and is now 3000 ft., and by means of some blasting executed at the outlet of the Mösvand, it became possible to lower the level of the water from 2957 ft. to 2952 ft. The regulation completed, the difference of level between low and high water is 47½ ft., and the basin contains about 26,720,000,000 cu. ft.

The Mösvand dam is built of concrete, the mixture being 1:3:5. The maximum height of this dam is 65.6 ft. The top of the dam lies at a level of 3001 ft. above sea level. It has been constructed with a weir 147 ft. wide, the sill of which is at a height of 2992 ft. above sea level. The outlet is controlled by needles. The discharging of the reservoir for the upper 23 ft. is effected through 3 sluices built in the dam, and for the lower 23 ft. through 6 bottom sluices placed in front of 2 tunnels excavated in the cliff on the north side of the dam.

The Rjukan Power Works commence about 5 mi. below the Mösvand dam, where a dam is being built across the River Maana on the top of Skarsfos, by which means there is formed an intake reservoir of about ¼ sq. mi. area.

The Skarsfos dam has a maximum height of 47.5 ft. In the deepest part it has a discharging sluice, and also an outlet for ice 16½ ft. broad, controlled by horizontal beams, and 2 outlets, respectively 171 ft. and 98½ ft. broad, controlled by vertical needles. The water is conducted from the Skarsfos reservoir to the power station of Vemork by a tunnel excavated in the rock. In front of the tunnel there has been placed a screen for stopping objectionable material. Each opening is 13 ft. broad, and can be regulated by horizontal beams placed in slides in concrete pillars. The tunnel itself can be closed by a large, stoney sluice-gate. The tunnel has an egg-shaped transverse section with a superficial area of 280 sq. ft., a length of 12,907 ft., and a fall of 29 ft., corresponding to an average fall of 1:480. In order to complete the tunnel as soon as possible, it was worked from each end, and also from 9 cross cuts as well. From the tunnel the water is conducted into the distributing basin, shown in plan in Fig. 5, cut entirely in the rock, the sides being lined with concrete.

The water tower has an area of about 10,764 sq. ft., and is covered over. In order to drain the tunnel and the reservoir there has been blasted a special discharging tunnel, leading the water out. From the distributing basin the water is conveyed to the power station in 10 large, steel pipes, the total height of the fall of these pipes being 941 ft. Each pipe is 2296 ft. long, and the diameter decreases from 79 in. at the top to 49 in. at the bottom. The upper 689 ft. of the line are of riveted pipes; the remaining 1600 ft. are of welded pipes. In the upper part, the pipes are conveyed by twos through 5 tunnels, passing from the distributing basin to the house containing the throttle valves. The arrangement is clearly shown at the right-hand side of the general plan, Fig. 5.

In order to reduce the danger of injuries arising from breakage of the pipes, there have been fixed in the

pipe line, directly below the distributing basin, automatic valves, by means of which the pipe line can be closed automatically in case the speed of water in the pipes is at any time too great. These valves can also be manipulated from the power station electrically. The pipes are fitted with the necessary number of expansion pieces. In order to facilitate the placing of the pipes, a railway was built beside the pipe line, as shown in Fig. 3. In addition to the original 10 pipes, there is now under construction an eleventh pipe, through which the water is to be conducted to 2 reserve units. The upper ends of the pipes are shown in Fig. 3.

The power station itself is shown in plan and transverse section in Figs. 7 and 8, respectively. It is built of cut stone; the interior length of the building is 360 ft., and the free breadth 67 ft. In the power station are 10 main turbines. There is in course of construction an annexed building for the 2 previously mentioned spare units.

Five of the turbines are constructed as double Pelton turbines, each driving wheel being fitted with 2 nozzles. Each turbine develops 14,500 hp. at 250 r.p.m. The water running from the turbines is collected in a common lower race, from which it is led back to the river at a point about 328 ft. below the power station. The water will eventually be led from this low race directly into the tunnel leading to the power works of Saaheim now under construction.

The turbines are directly coupled to 3-phase alternating-current generators of a normal output of 17,000 kv.a. each. Nine of these are constructed as double generators, consisting of 2 generators of 8500 kv.a. each, built together on a common shaft; whereas the tenth generator is built as a single machine, and probably ranks among the largest units in the world. The normal working voltage is 10,500, power factor=0.6. The exciter is placed on the main shaft, and the generators are entirely covered and self-ventilating. The air is drawn in from a common ventilating shaft, which passes under the floor of the power station for its entire length, and the heated air is discharged into the open on the rear side of the power station through a separate canal from each generator.

From the generators, cables in separate trenches are led into the instrument-room in a separate annexed building. All the necessary high and low-tension apparatus for the regulation, etc., are there installed, the apparatus being controlled from a switchboard placed on a balcony in the turbine room, from which the turbines may easily be seen. Through openings in the wall the power mains, which are stranded copper cables, are conducted out of the instrument room, each unit consisting of 6 cables of 150 sq. mm. each. In all, there are thus 60 copper cables leaving the building.

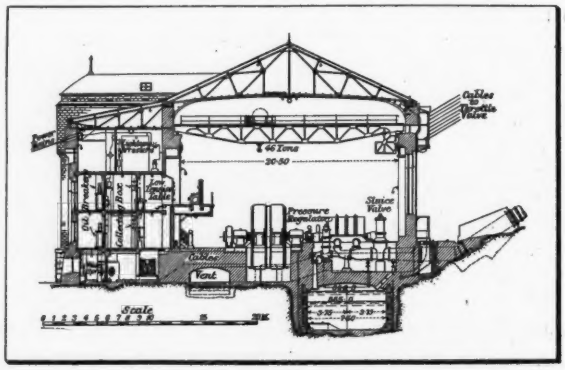


FIG. 8. VERTICAL SECTION OF POWER PLANT

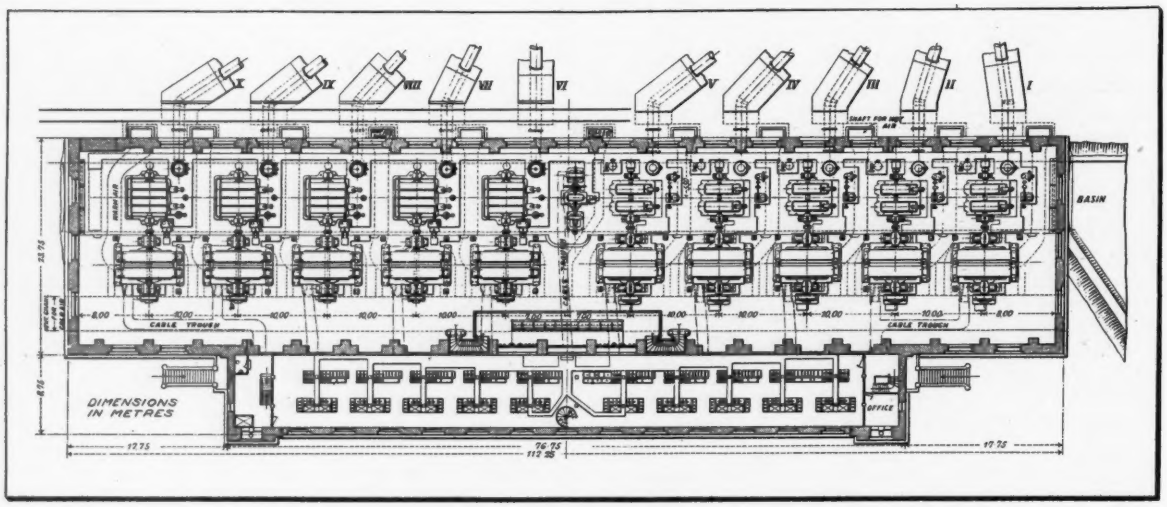


FIG. 7. PLAN OF THE POWER PLANT

The power mains have been carried overhead on long spans, as shown in Fig. 7. The supports on which they are carried are constructed of iron, and are erected on concrete foundations; there are 5 masts at each supporting point. Each of these masts carries cables large enough for 2 units. The average span is 328 ft., but in order to reach across the large ravine, it has been necessary in some places to go to a span more than 820 ft.

Copper cables have been used on the upper part of the line for a distance of about 5250 ft., while for the rest, 9840 ft., aluminum cables have been used having a section of ½ sq. in. The energy developed in the power station of Vemork amounts to 145,000 electric horsepower, which is utilized in the Rjukan nitrate factories.

The Saaheim Power Works, now in process of construction, is to be finished in the spring of 1916. It will develop in all, 135,000 electric horsepower, which will also be utilized for the manufacturing of nitrogen products on the Birkeland-Eyde system.—Engineering (London).

Pioneer Engineering

THE FIRST STEAM LOOP AND RETURN STEAM TRAP. BY W. H. ODELL

AMONG engineer associates of the writer's young manhood none was held in higher esteem or did more for his fellow men and received less in the shape of financial returns than the late James H. Blessing of Albany, N. Y. Among other things, Mr. Blessing, as we will show in this article, was the inventor of the steam loop and out of this invention grew the modern return steam trap. The old saw, "Necessity is the mother of invention," surely applies to this case. Mr. Blessing belonged to that old school of mechanics who started as a boy in the machine shop, served his apprenticeship and then rose through all the grades until he became superintendent of the Townsend Foundry & Machine Works, of Albany, N. Y.

About 1868, the proprietors of this shop determined to move the plant nearer the river front, and as it became Mr. Blessing's duty to design a heating plant for the new works, he determined to use the exhaust steam from the engine when running to heat the foundry and upper floors, and to use live steam for the office, machine and pattern shops, taking this from a boiler specially installed for that purpose. It was intended that this special boiler should be set in a pit low enough so that all condensation from the heating system of the lower floors would flow back to it by gravity. This plan looked well on paper, and everything seemed plain sailing, but right here he ran onto a snag that was not anticipated, although it was undoubtedly a "blessing" in disguise, as it gave first the steam loop, and soon after followed the return trap.

We can readily understand this young engineer's consternation when, in the course of erection of the new buildings, it was learned that each tide in the river caused the water level to rise higher than the fire-box of the boiler as planned. To set the boiler in a tank, anchored to prevent its floating, would have been expensive and impracticable, and in the effort to solve this unlooked for problem, Mr. Blessing's thought turned to some method of returning the water of condensation by gravity or without the use of pumps, which up to that time were the only means available. Here he invented his first steam trap, and put it in use.

This first trap was merely a casting, the upper and lower halves being separated by a flexible diaphragm with the water entering through a suitable check valve under the diaphragm until the upward motion opened a valve in the steam pipe direct from the boiler and balanced the pressure, permitting the water to flow onward through a second check valve back to the boiler. Although this diaphragm trap was successful up to a certain point, it did not answer all the inventor's demands, but did bring to light several interesting facts for the consideration of his alert brain.

Among other things he discovered that the inlet pipe for conveying the water of condensation to the trap from the coils contained both steam and water, for after the first condensation, due to the extra amount of steam condensed when steam was first let into the heating apparatus was worked off by a few rapid discharges of the trap, it would take several minutes to collect enough water to fill the trap again, and while this was refilling he could hear the check valve on the inlet pipe rattling on its seat, caused by water and steam passing through it.

Thinking over this matter he realized that after all the coils and radiators were only a part of the direct steam pipe that conveyed steam through them and finally to the small pipes used for collecting the water of condensation. It followed that, if this small return pipe was connected to the top of a proper sized vessel and placed a proper distance above the water level in the boiler, the water and steam would pass over into the receiver where the water would fall to the bottom and be separated from the steam.

Steam pressure in the receiving vessel would be about the same as the pressure in the system at the farthest point from the boiler, and if this pressure was near enough to that in the boiler and the receiver was placed at a height sufficient above the water level in the boiler, so that the solid water column would make up for the difference in pressures, the water would gravitate into the boiler through a return pipe extending from the bottom of the receiver.

With this understanding of the problem he prepared a spherical vessel 12 in. in diameter as a receiver for the system on which he was experimenting and placed this on the floor above the one on which the boiler and coils was situated, and about 9 ft. above the water level in the boiler. After the receiver was connected and steam turned on and the first water of condensation and air removed by blowing to the atmosphere, circulation was established and maintained as long as the pressure in the boiler was sufficient to lift the water of condensation from the coils and radiators up to the receiver, giving a practical operating steam loop system.

After this device had been in successful operation for several months in the new plant, the inventor determined to try it out in another place, and here came a second experience which was as instructive as the first.

Messrs. Weed & Parsons, printers of Albany, had just installed what at that time was a modern steam heating system, taking steam direct from the boilers and returning the condensation, mixed with colder water back to the boiler by means of a steam pump which it was desired to replace. Investigation found a place about 10 ft. above the water level in the boiler where the receiver could be located, and after connecting up the system and making several attempts to start, it proved a blank failure. Further investigation showed

a difference of about 8 lb. pressure between that of the coils and the boiler, which explained why it was impossible to get circulation started, for under these conditions it would require a height of some 24 ft. for the return column, or about twice the head available.

To enlarge the steam pipe so as to make the return pressure more nearly equal that in the boiler would have been extremely expensive, so Mr. Blessing made a change by taking down the receiver and suspending it on one end of a counter-balanced lever, then adding a steam valve for admitting steam direct from the boiler into the top of the receiver, so as to equalize the pressure with that of the boiler. Here was born the first practical return trap, which became known widely as the Albany gravity steam trap. Mr. Blessing received a patent on this device dated February 13, 1872, and reissued August 27, 1873, and in the first claim of the re-issue patent the device known as the steam loop was fully covered. The question of this claim and of the litigation in regard to it is a matter of court history which can be found in the records by those interested.

The thought of the writer of this article is simply to give credit where credit is due, to a man who was always willing to help the men under him and who was responsible for the introduction of many useful devices in the operation of steam plants.

Improvised Mine Fires

An Underground Fire Chamber for Experiments on Spontaneous Combustion and Mine Fires

THE Bureau of Mines has recently installed at its Pittsburgh experiment station an underground chamber or furnace in which to carry on experiments relating to mine fires and spontaneous combustion as occurring in mines.

FIG. 1. SIDE VIEW OF "COMBUSTION OF COAL" APPARATUS

A section of steel tube, cylindrical in shape, 6½ ft. in diameter and 27 ft. long, was laid on its side in a deep trench, and after lining this shell with fire brick and mineral wool and stopping the ends with 13-in. brick walls, it was covered with 2 ft. of earth. The chamber was constructed so as to be as nearly airtight as possible, and in such manner as to retain to the greatest degree practicable any heat generated within its walls.

At one end a motor-driven fan will blow in air at a rate which can be accurately measured, and at the other a stack is provided which can be opened or closed as desired. Through the top of the chamber, at frequent intervals, pass small pipes for withdrawing samples of air or gases and from inserting pyrometers for temperature measurement in the interior.

The chamber will hold 6 to 8 tons of coal when ⅓ full. It is expected that different kinds of coal or of the gob or waste material from mines will be placed in the chamber and a study made of spontaneous development of heat in them under various conditions. After an active fire has been started in the chamber, either by this means or artificially, experiments will be made on controlling the fire by reducing the air supply or by

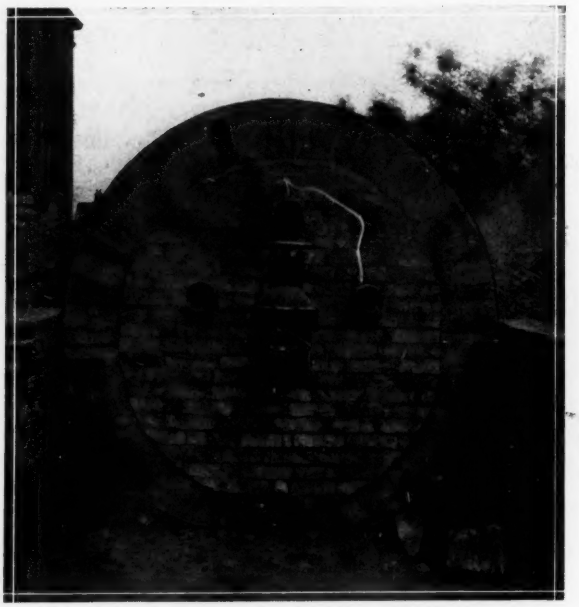


FIG. 2. VIEW OF "COMBUSTION OF COAL" TESTING APPARATUS, SHOWING GAS AND AIR CONNECTIONS TO COMBUSTION CHAMBER

sealing it off entirely. The progressive changes in composition of the fire gases or of the air surrounding the coal will be followed and temperature measurements made, in an endeavor to apply the date thus obtained to solving practical problems in the treatment of mine fires.

Investigations have been made in other countries and to some extent also in this country, of the gases produced in actual cases of mine fires, both before and after sealing off a burning area. The bureau is now making, however, probably the first attempt to investigate such problems in an experimental apparatus which permits careful control of conditions and yet is on a scale nearly commensurate with mining operations. These investigations are being carried on by Horace C. Porter, chemist, of the Bureau of Mines.

THE GREATEST trouble of a man who is minding his own business is that so many want to help him.—Albany Journal.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

A Two-Cycle Oil Engine Test

By D. O. Barrett

ALTHOUGH it has been on the market but comparatively few years, the 2-cycle oil engine is fast becoming a formidable competitor of the 4-cycle gasoline engine, as the heavier fuels quite naturally fall into the field of the stationary engine.

While the manufacturers of the 2-cycle oil engines claim low fuel consumption, figures of few tests on such engines are published which give the reader even a fairly accurate idea of the amount of oil used by such engines per horsepower-hour. A few results of a test made upon an 80-hp. engine of this type will be here given.

The scavenging air is compressed in the inner end of the cylinder and not in the crank case, as is done in the majority of 2-cycle engines. This construction leaves the crank case open, allows easy access to the main bearings for repairs or adjustment, and prevents overheating, due to the compression of the air.

Figure 1 shows a cross-sectional view of the engine. The bore of the cylinder was 16 in., and the stroke of the piston 24 in. The piston is shown at the inner end of the cylinder with the transfer and exhaust ports com-

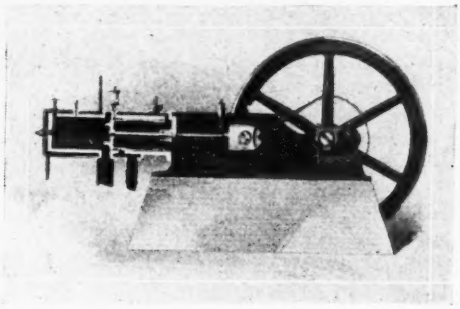


FIG. 1. LONGITUDINAL CROSS-SECTION OF PRIMM ENGINE

pletely uncovered. The exhaust ports are opened considerably ahead of the transfer ports; but they extend clear to the end of the stroke, giving an extremely large exhaust opening. The engine is of the 3-port type, the intake port being on the lower side of the cylinder. This style of engine consumes a little extra power, due to the suction created in the pump chamber; but when it is considered that there are no valves whatever in operation, these ports being opened and closed automatically by the movement of the piston, this slight loss is more than offset. This type of engine is also quiet when running.

The hot tube method of ignition is the one employed in the engine and in starting, the ignition tube in the upper part of the cylinder head is removed and heated in a blast lamp to a dull red. The cylinder is primed with a little gasoline, and in the larger sizes compressed air is used for starting purposes. Gasoline is also inserted through the priming valve at the front end of the cylinder, enabling the engine to run a few minutes in order to heat up the steel plate which is shown at the end of the piston in Fig. 1.

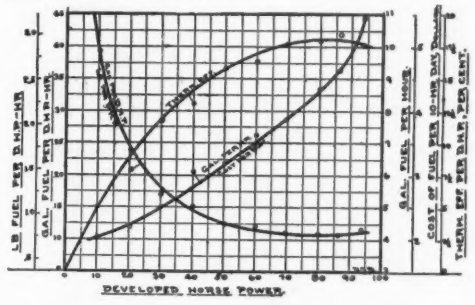


FIG. 2. FUEL CONSUMPTION CURVE

After a few explosions, this plate becomes sufficiently warm to vaporize the oil which is injected by the fuel pump through the spray nozzle in the center of the cylinder head.

Fuel oil of 32½ deg. Beaume, weighing 7.2 lb. to the U. S. gallon, was used on the test of this engine. In the calculations, the heating value of this oil was assumed to be 18,000 B.t.u. per lb. The results of the test are given in the accompanying table, 10 runs being made in order to obtain a sufficient number of tests from which curves might be plotted.

It will be noticed that the maximum horsepower developed was 94, or nearly 120 per cent of the engine's rating. These engines are conservatively rated, a feature which should be observed on all heavy oil engines.

The fuel consumption curve in Fig. 2 is interesting for the almost flat part of the curve from 60 to 95 hp., showing that between these points the fuel consumption remained practically at a minimum; this, in any engine, is a valuable feature, and seems to be characteristic of this engine.

The lowest fuel consumption per developed horsepower-hour was 0.107 U. S. gal., or 0.77 lb., which gives a cost of 0.53 cents per developed horsepower-hour. The total gallons of fuel per hour was also plotted, as well as the cost per 10-hr. day, with oil at 5 cents per gallon. At 80 developed horsepower, it will be noticed that the cost per day was about $4.40. The actual price of the fuel with which the engine was tested was, however, 3.35 cents per gallon in carload lots, which would bring the above cost per day down to $2.95, which is a rather low figure for this amount of power, considering the cost

of fuel as used in the average gasoline engine. It will be noticed that the fuel-per-hour curve rises quite abruptly after reaching about 90 hp., showing the advisability of running the engine at or near its rated power.

The highest thermal efficiency was 18.4 per cent at 86.5 developed horsepower. This figure is obtained by dividing 2545 by the heat units in the oil used per developed horsepower-hour.

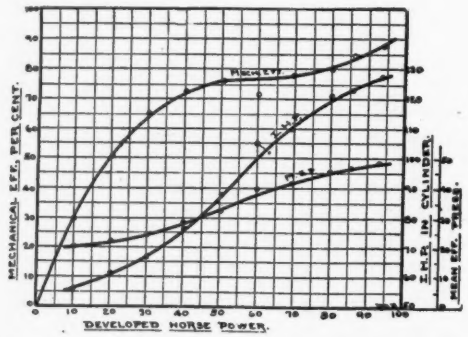


FIG. 3. HORSEPOWER AND EFFICIENCY CURVE

The heat units are obtained by multiplying the pounds of fuel per developed horsepower-hour by 18,000.

In any internal combustion engine it is difficult to obtain satisfactory indicator cards representing the average conditions covering any stated period. In this test, 6 cards were taken at the beginning and 6 at the

1 Number of run	1	2	3	4	5	6	7	8	9	10
2 Dev. horse power	10.5	21.0	30.3	40.6	51.1	60.2	69.9	80.3	87.5	96.0
3 Gal. fuel per hr.	4.10	4.39	5.07	6.15	6.38	7.32	7.77	8.78	9.37	10.38
4 Gal. per d. h. p.-hr.	.390	.209	.167	151	124	120	110	109	.107	.116
5 Lbs. per d.h. p.-hr.	2.81	1.50	1.20	1.09	893	864	794	.785	770	835
6 Therm. eff.-d. h. p.	9	9.4	11.4	13.0	15.3	16.4	17.8	18.0	18.4	17.6
7 M. e. p. in cyl.	30	32	34	38	39	39	41	45	46	48
8 M. e. p. for i. h. p.	13.7	14.7	15.7	20.7	24.7	31.7	33.7	37.7	38.7	40.7
9 Indicated h. p.	23.6	41.2	46.6	56.5	67.4	85.0	90.0	101.1	102.7	107.7
10 Mechanical eff.	29.5	51.0	65.0	72.2	75.7	71.0	77.6	79.5	84.2	87.3
11 Total i. h. p.	36.0	61.6	67.0	78.4	87.4	104.5	108.5	120.5	122.2	127.0
12 B. t. u.-i. h. p.-hr.	9000	9240	9630	10630	9440	9360	9130	9450	9830	11150
13 Therm. eff.-i. h. p.	20.5	37.6	25.9	24.4	27.6	29.4	27.9	25.9	25.9	25.8
14 Total i. h. p.	46.6	56.5	67.8	79.3	86.6	97.7	107.4	117.8	124.0	131.5
15 Lb. per i. h. p.-hr.	.635	.541	.530	.569	.515	.531	.516	.537	.526	.569

FIG. 4. TABLE OF TEST RESULTS

end of each run. The interesting point about these was that the conditions of ignition were practically constant, due to the satisfactory operation of the governor used on this engine, which maintained the speed exceptionally steady, so that during the test the engine ran practically as well as a steam engine.

The curves in Fig. 3 represent the mechanical efficiency, the indicated horsepower and the mean effective pressure.—Gas Review.

Standardization of Gas Engine Parts

AT the annual meeting of the National Gas Engine Association, which was held at the La Salle Hotel, Chicago, June 24, 25 and 26, the Standardization Committee recommended that measures be taken to standardize certain parts of the gas engine. Among the important items to be standardized in the near future are the belt speed, the horsepower rating and the brake.

During the discussion, it was pointed out that many thousands of dollars may be saved, not only to the manufacturer, but the dealer and user as well, by selecting and employing some standard of the above 3 items.

Diesel Engine "Don'ts"

GOOD MODERN DESIGN OF THIS TYPE ENGINE AND CARE REQUIRED. BY H. R. SETZ

WITH regard to the points brought out by John Pierce in the issue of June 15 as to the operation of the Diesel engine, a few remarks may be appropriate with regard to the most modern types and designs.

Taking up his suggestions in order:—First, any piece of machinery which has to undergo as steady a grind as a prime mover in a power plant, requires intelligent attendance, systematically given, which will reduce to a few daily routine manipulations. The Diesel engine does not differ in this respect from the Corliss or any other steam engine, although the routine is different, but not so strenuous as to cause any whitening of the operator's hair.

No amount of intelligent care on the part of the operator can prevent breakdowns if the engine parts are of unsuitable design or inaccessible, and it is up to the builder so to design his engine that the condition of all parts can be easily ascertained at any time. If an engine is not so designed, Mr. Pierce is wrong in taking the blame on himself for resulting unfortunate experiences.

The second rule is a good one, and is heartily endorsed by the writer.

In regard to the 3rd and 4th suggestions, as to regular putting of water and oil in the crank case, I believe that a modern Diesel engine should be equipped with a positive system of lubrication. The oil being continuously circulated through a filter, continues through adjustable sight feeds, in well defined quantities, back to the places where it is needed. Keeping these sight feeds properly adjusted, and occasionally cleaning the filters when the gages indicate this to be necessary, is part of the operator's routine work. Everything should be at all times plainly visible, and require no special instructions to secure attention.

As to the 5th and 6th points, with regard to the level of the oil in the supply tank and keeping water out, arrangements should be made so that the engineer can, at a glance, tell the water level in the bottom of the tank, so as to keep this at a safe limit and prevent water from getting into the oil line.

The 8th suggestion, as to cleaning the screens, should be taken care of by having a filtering system, which can be looked after and kept in working order while the engine is running. With gages, it will tell the operator just the condition of the screens at all times.

As to draining the bottom of the feed tank occasionally, this is a good rule where such a tank is required at all, but in most modern engines, this tank has been done away with.

Looking after the cooling water, suggestion 10, is part of any engineer's routine work, but independent, visible overflows should be provided from each part to be cooled, so that quick information can be gained on this point, and the 11th suggestion is not necessary with the best modern engines, as the circulation of water through the cooling jackets, automatically cools the needle valve. The drains for the needle cooling water, as mentioned in 12 and 13, would be eliminated by this modern design.

Fourteen and 15 are suggestions that apply to all engines of Diesel type.

As to the needle valve levers, and the timing of the needles, suggestions 16 and 17, in the latest Diesel engines, the cams and clearances between cam levers and needle valves are positively set. Proper lubrication, cams and rollers of suitable width, absence of push rods, and the consequent direct operation of cam needle valve by a single rocker arm, are guarantees of the maintaining of the original setting, the same as when the engine leaves the shop.

As to the tightening of valve glands and changing of springs, suggested in 18 and 19, the modern design of Diesel engine should have no glands on any of its valves, so that very light springs can be used, and with a moderate load imposed on them, will have almost indefinite life and elasticity.

For the packing of the delivery side of the fuel pump, if proper material is used, and the plunger properly heat-treated, repacking will be necessary only at infrequent intervals, and the pump plungers will require but little attendance, since worn packings and plungers will develop gradually and very slowly.

In the fuel pumps, suggestion 22, the best modern design has the pins and levers, where used for operating suction valves, continuously submerged in oil, so that the wear is negligible.

Suggestions 23 and 24 are good, and apply to all engines.

As to 25, on the setting of the fuel needle cam, if the cams are of the latest design, as noted under 16 and 17, no resetting will be required, so that this "don't" will be eliminated.

Draining the water from the air receiver should be done every day, as it is simply a matter of opening a small drain cock, and the air storage bottles, mentioned in 27, should be recharged after every start, so that there will never be possibility of finding them empty.

As to the kind of oil for the crank case, mentioned in 28, a great variety of mineral lubricating oils, as well as fuel oils, can be used in a well designed Diesel engine, but the packing, mentioned in 29, should be used of the brand recommended by the engine builder. Only a small quantity is required, and it is not worth while to experiment.

The breaking of exhaust valve springs, mentioned in 30, or any valve springs, for that matter, is an extremely rare occurrence in a modern Diesel oil engine, and would indicate, if it happens frequently, that there is something wrong with the design or with the springs.

Rules 31, 32 and 33 are very much to the point.

As to rule 34, if haphazard lubrication is depended on, certainly the fact that bearings are swimming in oil will be no assurance against trouble, but a system of lubrication should be used which carries the oil into the bearings in definite, predetermined quantities.

Rule 35, with regard to the examining of the crank case, should not be necessary with a modern engine, as there should be no parts hidden therein. Everything should be conveniently examined from the outside, under conditions which will insure proper care. If this is true, rule 36 will, of course, be eliminated.

The governor of a Diesel engine should not be exposed so that rags or waste can get into it. If for no other than mechanical reasons, and the securing of efficient lubrication, the governor should be enclosed preferably in a revolving housing.

Suggestion 38 is a good one, and deserves continuous attention.

Where the dashpot is used, suggestion 39 is good. The dashpot should, of course, be kept filled with oil, but in a number of modern Diesel engines, fuel pumps are so constructed that the dashpot is done away with.

As to rule 40, if the plant is properly arranged, the trouble with the fuel pump delivery checks will be anticipated by the operating engineer periodically going over the valves of the pump, which, with proper design, can be done in a few minutes.

Forty-one is a suggestion worth remembering and acting on.

With regard to 42, it is well to keep posted on what is going on in advances in oil engine design. Some day you might have occasion to recommend that the boss buy an oil engine, and you might get improvements which would save many of the unpleasant experiences which Mr. Pierce has encountered.

Rule 43, "Don't forget to keep her clean," is the most important rule for any Diesel engineer.

Flywheel Weights for Internal Combustion Engines

IN calculating the weight of flywheels for internal combustion engines, it is incorrect to accept the same figures for an engine operating on the hit-and-miss principle as those for an engine working under throttling control. The interval during which there is no explosion stroke in the hit-and-miss engine, is marked with a fluctuation in speed which is nearly double that of the working stroke cycle, and it is partly for this reason and partly to secure economy in gas consumption that the throttle governor, though more complex, has been adopted for high power engines, especially those used for driving electric generators. The hit-and-miss type is almost solely used on small engines where the increase in the weight of the flywheel is not of so much consequence.

Let W be the energy developed in the cylinder during the engine stroke, and W_1' the energy required for the compression stroke. The energy absorbed by the flywheel when throttle governing is used, is, $E = (3W + W^1) \div 4$; when the hit-and-miss governor is employed, $E = (7W - 3W^1) \div 4$. Also, $E = 2k\,E^1$, in which k is the co efficient of fluctuation of speed, and E^1 is the energy in the flywheel at the mean speed.

To illustrate the use of these formulas, let the weight of a flywheel be determined for a gas engine having a cylinder of 8 in. diameter, a stroke of 10 in., and running at a mean speed of 250 r.p.m.; assume the average pressure of explosion stroke for full load to be 90 lb. per sq. in., average compression stroke pressure 20 lb. per sq. in., and coefficient of fluctuation of speed to be 0.02.

Then $W = 8 \times 8 \times 0.7854 \times 90 \times 10 \div 12 = 3770$ ft.-lb., and $W^1 = 8 \times 8 \times 0.7854 \times 20 \times 10 \div 12 = 837$ ft. lb. Substituting these values for W and W^1 in the above formula, we have for hit-and-miss governing a value of $E = 5970$ ft.-lb. The weight of the flywheel (in pounds)

is obtained by the formula W = 3600 gE ÷ 4 pi 2 R 2 N 2 k, in which g = 32.16, N = r.p.m., k = 0.02, and R = radius of gyration of the flywheel. Assuming the radius of gyration to be 2 ft., and solving, we have W = 3500 lb., 2 wheels each of 1750 lb., would probably be used. Similarly, for throttle governing, the value of E is found to be 3037 ft. lb., and W equals 1780 lb.—National Gas Engine Ass'n Bulletin No. 69.

Good for Diesel Engines

AFTER 10 yr. of continuous experience in the operation of Diesel oil engines, a St. Louis chief engineer is high in his praise of the use of flake graphite on the packings and in the crank cases of those engines, especially where an emulsion of oil and water is maintained.

He relates being able to operate Diesel engines 5 months without the readjustment of any bearings, by placing 5 or 6 oz. of flake graphite in the crank case 2 or 3 times weekly. It travels up the cylinder walls and adheres to the metal, thus reducing the wear of the cylinder, pistons and rings, as well as the bearings, to a minimum.

The best results with packings may be obtained by boiling them in a mixture of flake graphite and cylinder oil, allowing them to absorb all of the graphite possible. After this treatment, the packing should not be used for 3 or 4 weeks.

Trouble with Water Jacket Piping

THE arrangement shown in Fig. 1 was devised by the engineer of a small ammonia compression plant to prevent the water jackets of the compressors from flowing over. This would occur at frequent intervals, and upon investigating for the cause, it was discovered that air became trapped between the overflow pipe and the point where it led into the sewer.

General arrangement of sewer piping is shown in Fig. 2. All waste water in the building passes through the running trap, T, before passing into the main sewer. The water used in the ammonia condensers is pumped from a series of driven wells by a motor-driven triplex pump, which pumps all the water used in the building, first through the double-pipe ammonia condensers, the outlet of which is connected to the branch tee, as shown, and is pumped to a storage tank located on the roof of the building. The level of the water is regulated by a float valve, and when this closes, the relief valve opens, when the water runs into the sewer.

When the triplex water pump was first started, it proved to be a noisy affair in operation. In order to insure a quiet running pump, a pet cock was screwed into the suction line, the opening of which was regulated to reduce the vacuum to a point where the pump would run as quiet as this type of pump can be expected to run. When the relief valve was closed, the air that went in with the water found relief through the float valve located in the water tank on the roof. When this valve closed and the relief opened, this air became trapped between the relief valve and the trap at T. The air, being lighter than the water, naturally could not find relief through the trap, but when the pressure became great enough, found relief through the pipe, P, forcing the water back into the jackets and causing them to overflow.

When this relief valve would open at the same time the water was let down from the sinks on the floor above, matters were even worse.

The belts that operate the compressors would become wet, causing them to slip, and anyone in the vicinity when this occurred would receive a shower bath on a small scale.

Owing to the location, the piping could not be enlarged, and it is doubtful whether, with the trap located as shown, any improvement could be made at this point. To relieve the air pressure, a piece of ¾-in. pipe with open end was screwed into the tee where the cylinder is located. This relieved the air; but it carried considerable water with it, which ran down on the floor of the engine room. In order to keep the water from coming out at this point, a cylinder was made up of 3-in. pipe and reducing couplings to act as a separating chamber for the air and water. The pet cock screwed into the top of the chamber is left wide open all the time, so that any water contained in the air separates in this chamber, the air passing out through the pet cock. After the pressure is relieved, the water runs back into the sewer pipe.

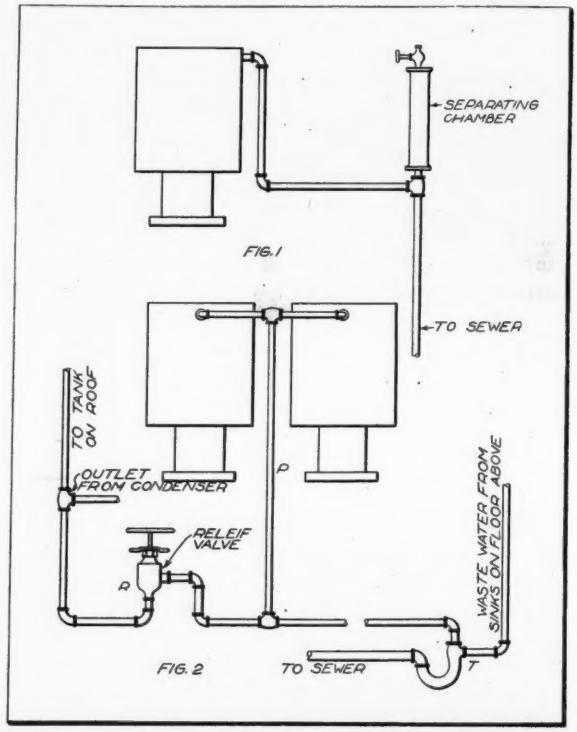


FIG. 1. OVERFLOW PIPING OF CONDENSER WATER JACKET
FIG. 2. PLAN OF SEWER PIPING

The arrangement, simple as it is, has eliminated the whole trouble. It will be noticed that it is located a little below the level of the point where the overflow pipe is screwed into the top of the water jacket. This was done in order that, should the volume of water become too large at some future time, it would pass out through the pet cock instead of causing the water jacket to overflow.

Preparing for Panama Canal

By R. E. Ireton

WHAT is probably the most unique achievement of its kind in this country is the new 2-story pier, or double-deck dock, recently completed at the Bush Terminal, Brooklyn, N. Y. This mammoth structure overshadows in bulk and capacity any pier in the United States at present. It is 1400 ft. in length, 270 ft. wide, and more than 50 ft. in height. It cost $1,000,000 and required the services of 400 workmen for almost 7 months. All records in pier building were broken in its construction, and the whole undertaking, from start to finish, was supervised by Clair Foster, one of the Bush Terminal Co.'s vice-presidents. The Bush Terminal Co.'s engineers made the plans and directed the whole operation.

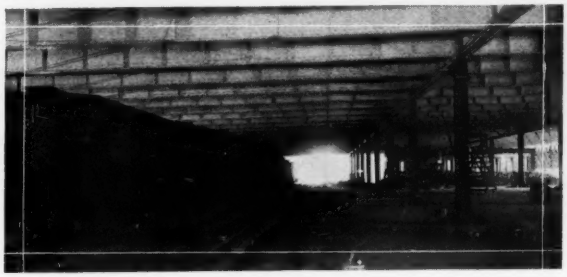


FIG. 2. LOWER FLOOR AND CAR TRACKS ON BUSH TERMINAL PIER

All space on its 2 floors is available for use, with head room of about 23 ft. on each. The slips adjoining it have been dredged to a depth of more than 40 ft., so that 6 transatlantic liners can be accommodated at the same time without the slightest difficulty. In the middle of the lower floor, or deck, is a double track railroad, embracing half a mile of track, which connects with the Bush Terminal Railroad at the bulkhead, an integral part of the trunk lines entering the port of New York,

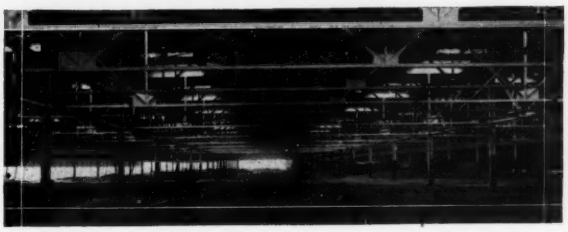


FIG. 3. UPPER FLOOR OF PIER SHOWING FLOOR AND ROOF CONSTRUCTION

so that long trains of freight cars can be operated without interfering with the loading or discharge of cargoes. The pier has been leased to the American-Hawaiian Line, and under the new schedule of its sailings fully 1,500,000 tons of freight will be handled annually at this great pier.

Its foundation piles were driven 30 ft. below low water and sawed off just below the surface. Grouped in lots of 10 to 30, they are capped with concrete hoods, measuring 11 ft. each way, and on these the steel columns supporting the structure are set. Metal has been used wherever possible in this pier's construction. The lower floor, or deck, consists of special asphalt block, chemically treated to make it fireproof. Over the steel girders on the upper floor 4-in. flooring is laid, 5 overlapping layers of heaviest tar paper, 1 in. of yellow pine

FIG. 1. SIDE VIEW OF 2-STORY PIER AT BUSH TERMINAL

planking and another inch of maple on top. The seams are filled with melted tar to make the whole waterproof and airtight. In addition to its fireproof construction, this pier is equipped on both floors with an automatic sprinkler system.

Commandant Clarke, of the Great Lakes Naval training station, is in receipt of orders from Washington to prepare for the breaking of ground at that point for the power radio wireless plant which the Government planned some time ago to erect there.

This means that in Lake County, Ill., there will be located one of the United States wireless stations, which will be a link in the chain of wireless points with which it is planned to circle the globe. By fall, the men at the post will be able to communicate with points as far away as Mexico, San Francisco and Washington, D. C.

The plant, as it is planned to have it installed, calls for the erection of 2 giant towers, each 400 ft. high and 600 ft. apart. These will be used as the receiving and sending shafts and will be among the highest to be found in the world, outside of those located on the tops of mountains. The wireless apparatus will be operated by radio and will be most powerful in the Central West.

In speaking of the matter recently, Commandant Clarke said: "It will probably be completed by the first days of fall and at that time the station here will be able to communicate with all parts of the world. We will be in direct communication with Washington and will receive all our orders over the wireless route. In times of floods we will be in a position to obtain information regarding the situation and act accordingly. Ships on the lake in distress or in want of information will be able to reach us and we them. In this we will be independent of transferred messages."

Correspondence of An Old Engineer and His Son

SANDY RELATES HIS ENGINEERING CAREER

MY DEAR SON—and Daughter, I suppose I should say:

We have at hand your very welcome letter of recent date, and while we have been expecting that you would soon "pass over to the silent majority," sooner or later, yet the announcement of your marriage to Hazel came as a surprise, to say the least.

Yes, I suppose that it was impossible to take a "bridal tower," as we used to call it. Almost any other man in the establishment can get off to get married but the engineer. He can hardly get off to die. The average firm generally expects him to die on the job. Don't let this discourage you, Donny, it's all in a day's work.

But, we are both pleased beyond measure to know that you are planning to attend the Big Convention in Milwaukee this September, and will visit us also. The latch string is always out and the door is never locked to a MacDougal that has "made good."

Your letters have been very interesting and were read many times each. Although it is not possible to convey with pen and ink the many petty little annoyances that creep into one's daily tasks, yet I could readily understand by reading between the lines that you were having a hard row to hoe, but I am pleased beyond measure to see that you have kept the weeds down and have raised a large crop.

But you will find, Donny, boy, that you are right now in just about the same position as the boys when they graduate from school or college. They call it "Commencement," but feel that it is the other end, and do not realize that they are commencing, until they pass on with life's procession, and when too late, they find out that "Commencement" WAS commencement, and not the end.

As I said, you are now right at this point; you have had your commencement. You have worked hard and have actually worked your way up a little. True it is, that the retirement of the Chief hastened matters some, but as a matter of fact, even if he didn't retire for years to come, there are places where you would have fit the gage and rolled on up the line of hard work to success and better position.

Often one hears men say that such-and-such a person has "reached the top." Possibly they are speaking of themselves the same as some pompous men boast that they are "self made men," only they neglect to add that the blueprints were not drawn to scale. But about the top.

There is no such a thing as the top. Admitting for the sake of argument that there *is* a top beyond which no one can ever go in his particular line, what ambition will a man have when he gets that far? If he found that he had really reached the top, that point beyond which there was nothing more to learn or to aspire for, it would throttle the ambitions, the hopes of reward, and the expectations of satisfaction in work well done, and back he would go, down the Georgetown Loop of life, around the treacherous curves of "don't care," over the dizzy trestles and grades of "what's the use," and if he stayed on the rails that are ever getting crookeder and more uneven with the passage of time, he would run into the open switch of fate, run over the flagman of "cheer up," knock out the bumper at the end of the scrap track, and plunge over into oblivion.

No, there is no top. As soon as one gets to a point that he has sort of set his eyes on years before, there arises before him, if he has red blood in him, a new goal to which he feels that he must aspire.

The president of one of the largest railway systems in the country said that if he knew of a fireman on his entire system that did not aspire to be president of the road some day, he would fire him as lacking the proper stamina to be a railroader. This president knew what he was talking about because he, himself, started as a fireman, when cord wood was the fuel.

Have I reached the top? Have I started back down "ambition hill" towards oblivion gulch, because I have quit the throttle and devote my spare time to helping mother about the house? Not at all.

One sometimes finds it better to change his "train of thought" to another system when he gets just so far along, and again one sometimes finds that he can still strive and hope for ultimate success by doing the work through some one else. Well, that's me.

Although I quit the throttle when you were a child, yet I had always hoped that you would take to that line of work, as it was born in you. I used every effort to put you on the right track, help you get up steam and give you your running orders, so to speak. And my son, you do not know what a sense of satisfaction comes over me in my declining years to see that you have such a good grip on things and that you have MADE GOOD.

Although my engineering train was switched over to the Farmers' Line, years ago, yet I have always taken a lively interest in things that run by steam. There may be all kinds of hydraulic, electrical, and explosive machinery developed and which has certain fields of usefulness, but the steam engine will be on the job long after your monument has passed on to the ages.

But you were asking about my early experiences as an engineer. The way I got my start was this: John Fleming was engineer for his brother Joseph, and the factory was located at 24th and Hamilton Sts., Philadelphia, at what was then called Fairmount.

The engine was a small one even for those days, and was a horizontal, or as John, in his Scotch way, called it, "a lyin' doon yen." John lived close by the job and at the time of which I write, his wife was seriously ill, and between the good wife, and a natural inclination of the crankpin on the engine to run hot frequently, John's mind was more or less in a whirl.

One day as he was rushing along to work, some one asked after the wife's health, and John, his mind at the moment on the engine, and not hearing clearly, said: "Oh, mon, she's a-heatin' at the crank yet."

With the addition of machinery the engine got too small, so they bought a new one of the gallows frame

type, or as later known, a beam engine. This stumped John. He could not run it. But he said, "if he knawed as mooch aboot a stan'in' up yen as he did aboot a lyin' doon yen, he wouldna gie up to ony mon runnin' an eengin'."

So they got a Bill Abrahams for engineer and John did other mechanical work about the works,—sort of millwright. Soon Bill wanted additional help, and my cousin James was taken on. Later, James went to Bruners' Mill, a 5-story cotton mill at 23rd and Hamilton Sts., and it was here that I was initiated into the engineering game. There were 3 large cylinder boilers and the engine was a "stan'in' up yen."

The first plant I had charge of by myself was in Joseph Carens' stone flour mill on Coats St., now Fairmount Ave., near where the Lincoln monument stands in Fairmount Park. The mill had 4 run of burr stones and ground 160 bbl. of flour in 24 hr., which was considered a record for years to come, in those days.

There were 3 boilers here also, but the engine was a "lyin' doon yen," and had to be packed with hemp, as there was no such a thing then as steam or spring packed pistons. It took about all of our extra time to braid packing for the piston, as it had to be hard, and slightly pointed at the ends. The piston had to be packed, by rights, every 24 hr., and if it went longer than 36 hr., it leaked so badly that it was hard to keep up steam. To pack, we had to take off the follower, hot, and remove the old packing and hammer in as much of the new as would go in, using hard wood sticks and a heavy wooden mallet. Then screw on the follower, take it off again and put in some more packing, etc., till the job was done.

This was in 1853, and I received $9 a week, 12 hr. a day. After that, I got a job running at Cob Creek, Delaware County, Pa., at $8 per week, but only 10 hr. a day. There was a pretty large horizontal engine and 3 large cylinder boilers. A water wheel was also on the driving shaft, and both engine and wheel had to be started and stopped at the same time. The lessee was a Frenchman named Sacrees, who, after I was there several months, wanted us to work 12 hr. a day for the same $8 a week, but we could not see the idea, and quit,—or resigned, as you would call it these days.

I then went canal boating on the Lehigh canal from Mauch Chunk to wherever we were ordered, and at the end of that season I got a job at running again at Daniel O. Hitner's blast furnace at Spring Mill, Montgomery Co., Pa. It was up the Schuylkill River from Philadelphia about 20 mi. or so. I got $40 a month. John Ware and I were the 2 engineers for a long time. The engine was built by Neil, Matters & Moore, near where the Baldwin Locomotive Works now stands. John Fleming, of whom I have made mention, learned his trade at this plant, and erected the engine at the blast furnace when he was but 22 yr. old.

This was a beam engine and the cylinder was 36 in. bore and 8 ft. stroke and had poppet valves, with 2 eccentrics, one for the steam valves and one for the exhaust, to raise the cams; when steam was cut off at 7/8 stroke their own weight closed them. Both the valves and the seats were cast iron and the valve seated like one teacup setting in another.

The beam and frame were very heavy and massive and the wheel was 24 ft. in diameter, which was the largest wheel ever cast at the time, to the best of my recollection.

This cylinder had 2 sets of metallic rings in the piston and 5 half elliptic springs under each, and at each spring center was a setscrew with jamb nuts to regulate the tension of the springs. We used a pair of fine-pointed compasses from the center of the piston head so that the springs had an equal bearing all around the cylinder.

We had to have a good block and tackle to get the follower to the top of the cylinder and block it so we could get inside and work. The blowing cylinder was the same stroke, 8 ft., and 96 in. in diameter. There were also 4 pumps operated off the beam with a 4-ft. stroke to lift the water from the Schuylkill river and force it up the hill about 300 ft. into a wooden tank where it settled and then ran into another one a little lower down, and still a third, from which it ran into the heater by gravity and on up to the 6 boilers at the tunnel head through regulating valves.

AULD SANDY HIMSEL'

The boilers were 60 ft. long, and the brick chimney at the rear 110 ft. high, and I have seen the fire rise 10 ft. out of the top of it. They poured off at 5 o'clock, morning and evening, and both sets of men had to be present. It was really an easy place for an engineer with no firing to do, as the boilers were fired by the waste furnace gas.

There was not a single oil cup on the entire engine. It ran 14 r.p.m., and when oiling the crank, you had to get the oil can into the small oilhole in the strap, and at the same time have the left hand free to hold a crude railing to balance by. This was in 1854-5.

I left there the latter part of 1855 and went to run an engine for Robert Selfridge in a large 5-story brick cotton mill that stood on the corner of 13th and Carpenter St., what was then called Meyamensing. It was several blocks south of the old city proper as laid out by William Penn. A political faction known as the "Know Nothings," at that time was down on all foreigners, which included me. Mr. Selfridge was a Whig, but he

turned democrat and let them put up a large flag, and a banner of Buchanan & Breckenridge, presidential candidates, out of the fifth story to a saloon on the opposite corner.

Shortly after, and before election, some one set fire to the mill and it was a total loss. He never rebuilt again, so I was burned out of a job. I got $10 a week there at first and he raised me to $11 later on, and on the Fourth of July he gave me $5 extra.

It just so happened that they wanted an engineer at another of Daniel Hitner's furnaces near the first one and at the same pay. Some little time later I heard of a better position as I thought—well, job is perhaps a better word,—and left to run an engine at Fountain Green, now Fairmount Park, between the Reading Railroad and the Schuylkill river, at $2.50 per day. I had to get up at 3 o'clock in the morning, put up my breakfast and dinner and walk 2 or more miles on the railroad and be at the works at 4 a. m. in time to start a 40-horse engine to blow 11 furnaces, some puddling and some heating. There were 11 boilers, one over each furnace.

The proprietor was a Mr. Alderman, and the superintendent was John McCarty, a very fine man. When he quit, his son Henry took his place. The engine that ran the rolls was a "lyin' doon yen," and had a cylinder dimension of 24 in. bore and 7 ft. stroke. Although the pay was very good here, the hours were long and the starting time of 4 a. m. not pleasant, so as soon as I heard of a better job, I took it. The little engine, in addition to running the fan, also ran 10 nail machines and a few other little machines.

I next went to a brewery, which was owned by Massey & Collins, as night engineer, at $10 a week, 12 hours a night. While there, Jas. Brunner's engineer was laid up for 8 days and Mr. Brunner asked me to run his engine days, and I could not refuse, seeing that I had learned my trade there. I worked at the brewery at night and got off at 6 in the morning, took a horsecar and was ready to start at Brunner's at 7. The watchman had steam up. I left a few minutes before 6 and Andy Young, a handy young fellow, looked after the engine for the short time remaining and stopped it.

I never slept during the week, and when Saturday night came I was worn out. Brunner paid me $9, and the $10 that I got at the brewery made me $19 that week, and did my own firing, as all engineers had to unless in the furnaces as explained above. That was the biggest wages ever drawn by an engineer in Philadelphia at that time, and you may be sure that I was envied.

A day job being open, I left the brewery and was engineer at Fisher's Lane, Germantown, now in Philadelphia, when Lincoln was nominated, and received $8 a week. It was a cotton mill, owned by a Mr. Reiley, and managed by Thomas Campbell, and the engine was a large one, although I do not recall the cylinder dimensions. There was water power also.

That was the last place I ran an engine as I went to Wisconsin in the fall of 1860 and in 1861 went out with the 3rd Wis. Infantry, helped to steal a locomotive down south, toggled up an engine that was minus an eccentric strap, on an abandoned plantation in Georgia, ground into meal the corn we "confiscated," and mixed in one or 2 other little affairs.

But I got sidetracked after the war onto the Farmer's Line. I am 83 yr. old, sleep well, never had a sick day, you might say, had every tooth in my head till 5 years ago, eat 3 meals a day, get up at 5 every morning don't owe a man a cent, have land enough to insure a living and can look back over my life without regretting a single action (with the possible exception of running engine in a brewery once, inasmuch as "Kansas is a dry town") and am satisfied with life.

I still have pride enough to have my picture taken occasionally and am sending you one of the latest.

But all this that has rewarded my own efforts to succeed along the financial line, does not begin to compare with you, my son, who have a MacDougal backbone in you, and the grit, determination, and stamina to start in on the back end of a wheelbarrow when your head was full of theoretical technicalities, swallow your pride, AND MAKE GOOD.

We both send Love to you and OUR DAUGHTER,

Affectionately, your father,

Sandy MacDougal.

How to Write Articles

PRACTICAL METHOD FOR NONPROFESSIONAL WRITERS. BY JOSEPH B. BAKER

THE practical engineer knows how helpful it is to find out how the other fellow does a given piece of work. The saying, "From every man according to his ability, to every man according to his need," applies especially to the sharing of experiences, and the way to reach the largest number is by an article in one's engineering periodical. Every engineer has ideas. His day's work is full of them: this repair job handily done, that permanent economy effected, that other big difficulty met. Even when things go smoothly, the engineer should be earning his salary in scheming to *prevent* trouble.

There is no reason why any intelligent engineer cannot write. With a good system the writing of readable and helpful articles is really an easy matter for the man who is in possession of interesting facts. The majority of practical engineers should be able to write about their experiences and not leave this work to a small minority or to the editorial staffs of the technical magazines.

The keynote of my own method of writing articles is Concentration. This method has proved practical and applicable to every topic, and will be set forth so that the reader can apply it to his own work.

In writing an article, the main thing is to write! Instead of sitting down before a ream of paper, wondering where to begin and how to frame fine-sounding sentences, and how to get it all in, concentrate on one idea at a time. Any engineering proposition, from the building of a dam for a great hydroelectric plant down to a rebabbiting job has 2 aspects essential to the matter viz., the actual conditions and requirements, and what was actually done to meet the requirements under the conditions. In other words, The Need, and The Way the Need Was Met.

Suppose you have done a rebabbiting job on the main bearings of your engine, and the job seems worth writ-

ing up because it was done in record time. Conditions: overheated bearings all forenoon, with the 2 bearings hard to get at and with only room for one man to work at a time on one of them. Requirement: to make a permanent repair and get the engine running before the one o'clock whistle blew. The meeting of the need might have been that the work could be put through without a hitch during the single hour's time.

Now to write the article, first concentrate upon The Need. Mentally ask the questions: Why was this job undertaken? What was sought to be accomplished? What difficulties were in the way? Think definitely, concentrating on each question as it comes up in mind and sticking to the particular point involved; then *write*, put down the answer to the question, no matter whether the questions and their answers are in any logical order or not. The main thing is that they come; they can be marshalled after they are mustered.

Use a medium-size pad of paper and keep my pen busy, leaving plenty of margin, plenty of room on each slip (paper is cheap, and to stint on paper cramps one's ideas), and writing on only one side of each slip. In starting to write an article I keep thinking of what The Need was for the work in hand—I go back in my thought to the inception, the reason for undertaking the work. Pen follows thought, putting down statement after statement, and the *moment* recollection in this section of the article runs dry, I pick up the group of slips—and it is a group very soon—and pack them into a sheaf, laying them to one side and picking up a fresh slip for tackling the next section, on The Need Met. The physical handling helps me to sort the ideas that come, helps alertness.

You, Mr. Practical Engineer, can do the same thing. Don't wait to get down on paper every last idea that there might be in this section of the article. The thing is to keep your steerageway on. When the work gets into full swing you can safely get down to the specific without danger of "getting lost in your subject." The work so far is just concentration and busy pen work, with a gratifying sense of progress every moment, because the pen is continuously busy and what it writes is much to the point. You need not bother about the final place where each idea should go; the only concern is to bring the mind to bear upon one particular phase of the subject at a time, let the words come as they will and set them down.

This kind of work is surprisingly interesting, and you will be gratified to see how much is accomplished. (You will be surprised, also, to find how fast the hands of the clock have been going around!) To be sure, about every slip has many corrections, afterthoughts put down in sorting and resorting the slips. Still, you can pick up the 2 sheaves of notes and hold them in the hand with the feeling that here is a draft of the article—something that can honestly be termed a draft. The next thing is to read this draft through—keeping the 2 sheaves separate. Read it all through—then begin to read again and jot in, by interlineation or by attaching separate slips, additional thoughts that come from the memory refreshed by the reading. As you write a thought under the head of The Need Met the mind may revert to what The Need was in the particular on which you are concentrating, and if that point was omitted, now is the time to put it in, at its proper place in the draft as penned so far.

After perhaps a couple of hours' work you have a manuscript which really comprehends the subject—incomplete, perhaps, yet with structure and grasp of the subject. The confidence and enjoyment of this success bring out latent ideas that no amount of chewing an idle pen would have dragged from their hiding-place. The article, forged by the hammer of concentration on the anvil of memory, grows apace. Before you quite realize it, you have the matter well in hand, and it only remains to cut out repetition, make sure all statements are clear, and arrange the points in logical order.

In most cases, of course, The Need Met section of the article will be the longer part. To write it may require measurements, computations, sketches; but by the method outlined in the foregoing there will be no question about the progress being made, and no feeling of baffle-ment or weariness with the job.

When the 2 sections, The Need and The Need Met, are carried to what may be called a near-finish, one is ready to write an Introduction and a Conclusion. Indeed, one may already have started 2 additional sheaves of notes under these 2 heads. The work is now seen to come under the 4 heads: 1, Introduction; 2, The Need; 3, The Need Met; 4, Conclusion. By our method, Nos. 2 and 3 have been written first, and in the work upon them the thought has been swung into action, steerageway and momentum have ben acquired, and new ideas latent in thought have been developed by the mental activity. To the writer's sense, No. 1 should be written after one's viewpoint has been settled, so to speak, by his review of the facts which comes with the writing of Nos. 2 and 3, because it will then be more in the nature of a summary of the body of the article—full of meat, and not mere sounding phrases. The same thing applies to the writing of the Conclusion.

Self Instructions

By J. H. Patterson

WHAT did I do yesterday that I ought not to have done, and what ought I to have done yesterday that I did not do, and what shall I do today?

In order to get the best results I must put down, in writing, things I plan to do, or else I will forget them.

Now, at the factory they used to forget many things, and so they issued an order, "Verbal orders don't go." If it was a good thing for the factory to issue to all of its people an order that verbal orders don't go, then it is a good thing for me to issue written instructions to myself—for what was a good thing for a good many people is a good thing for the individual.

So I will put down on one side the things I must eliminate from my daily routine, and on the other side the most important things I must do, because the first thing for me to do is to organize my own self, and I have never done that. I have never formed rules for the government of myself, rules which will get the greatest results with the least effort. There is no reason why I can't double my results in the same time, and be happier and better, if I only organize myself.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Condenser Experiences

AFTER TAKING charge of a condensing plant, in which the engine load was variable, due to the fact that water wheels were run in conjunction with the engine, and at certain seasons the water was low, the engineer found that the reason why he could not obtain more than 20 in. of vacuum in the cylinder was this:

The barometric condenser in use had been originally intended for the smaller engine which was replaced by the present engine, and was of insufficient capacity for good results. As the hot well was situated 3 ft. below the engine room floor, the condenser was located 34 ft. above the low-pressure cylinder in one of the rooms of the mill. On investigation, it was seen that the low-pressure exhaust pipe was 16 in. in diameter, but was reduced to 12 in. to make use of the old condenser. The engineer removed the cylinder head and found the area of the exhaust port to be ample for the piston speed and volume of exhaust handled when the engine was carrying 50 per cent overload, as it frequently did.

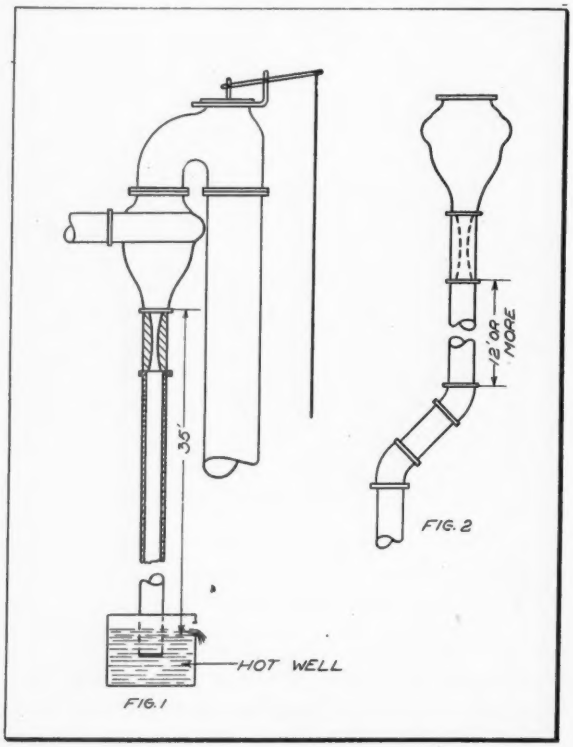


FIG. 1. LOCATION OF CONDENSER CONE AT LEAST 35 FT. ABOVE HOT WELL OVERFLOW

FIG. 2. ELLS NOT TO BE PLACED NEARER THAN 12 FT. FROM THE BOTTOM OF THE CONTRACTED PART OF CONDENSER

Horsepower per pound of mean effective pressure was found to be 38.63 hp. He reasoned that if he could increase the vacuum from 20 to 27 or 28 in., a decided gain in economy would result, inasmuch as the water was drafted by the condenser after starting the condenser by priming it.

As each gain of 2 in. in vacuum is roughly equal to 1 lb. pressure, a gain of 7 in. of vacuum would be equivalent to $3.5 \times 38.63 = 135$ hp. more with the same steam consumption, or a reduction in steam consumption of 135×16.75 lb. or 2261.25 lb. an hour, which would repay a considerable investment.

It was seen that, at little expense, the hot well could be lowered 37 ft., and the condenser cone connected by 6 ft. of straight 16-in. pipe under the engine room floor, which should also increase the vacuum, due to the lesser steam friction in passing to the condenser.

The matter was referred to a manufacturer, who guaranteed to maintain a vacuum of 27.5 in. with injection water at 70 deg. F., when referred to a 30-in. barometer. In due time the new condenser arrived and was installed; the results have fully justified the expenditure, and the engineer has risen in his employer's estimation, as evidenced when he had an opening to change to another plant and his salary was made better than that which the other would pay.

In installing this type of condenser, always be certain to get the condenser cone at least 35 ft. above the overflow of the hot well, as in Fig. 1. Another thing to avoid, is the introduction of ells to change the direction of the tail pipe, as these create friction and cause the water to stand at a greater height in the tail pipe. Bends are to be preferred when straight pipe cannot be used, and if a bend cannot be used, then 45-deg. ells may be employed, and they are not to be placed nearer than 12 ft. from the bottom of the contracted part of the condenser, as in Fig. 2.

Another engineer, hearing of the success of the case cited, induced his employer to enlarge their condenser and exhaust pipe, at considerable expense; the result was, he gained nothing, because, after investigating why better results were not obtained, it was found that the areas of the exhaust ports were too small, and the engineer had neglected to remove the cylinder head to investigate this.

This shows that before any changes are made, the matter should be thoroughly investigated from all angles, to prevent useless expenditure and the reputation of the engineer from suffering.

When it is necessary to pump water for a condenser, little, if anything, is gained by carrying over a 26-in. vacuum, because the volume of water required and non-condensible gases to remove, increase at an alarming rate as the higher vacuums are obtained, and require a greater expenditure of power than is gained. This applies to reciprocating engine practice.

When the condenser can be so situated that it will draft its own injection water, then the higher the vacuum, the better, as was the case above. RECEIVER.

Criticism of Diagrams

I HAVE just noticed the diagrams from the 16 by 42-in. single eccentric Corliss engine, upon which R. B. asks opinions of readers. (Page 369, issue of March 15.)

The diagrams are fair average diagrams, although I would advise a little earlier release; the head end admission should be a little earlier and the crank end admission a little later.

His remarks as to how the engine behaves are, to my mind, contradictory: he states that with the governor down so that the latch hooks do not engage with the valve arms, hence the steam valves do not open, and with the throttle wide open, the engine runs 24 r.p.m. This looks like leaky steam valves, and is just what one would expect an engine to do under such conditions.

He then contradicts the above by his statement, that by placing the crank in the proper position for starting and with the valve gear hooked up, that is the proper steam valve for admitting steam into the cylinder in the proper end for starting the engine is open, the engine will not start, but that, by releasing the latch hook and allowing this steam valve to close, the engine will start. Thus, closing a valve that should be open, starts the engine. R. B. does not state that the throttle is open while the latter experiment is being tried, but it would seem that it is wide open.

A logical question now arises: If, with steam valves remaining closed, throttle wide open, the engine runs 24 r.p.m. and with throttle and steam valve open, the engine will not start, just how is it started and operated so as to get 84 r.p.m. and a diagram as shown on page 369?

There is something wrong somewhere and R. B. should give a little more explanation. H. W. BENTON

Changing Air Pumps

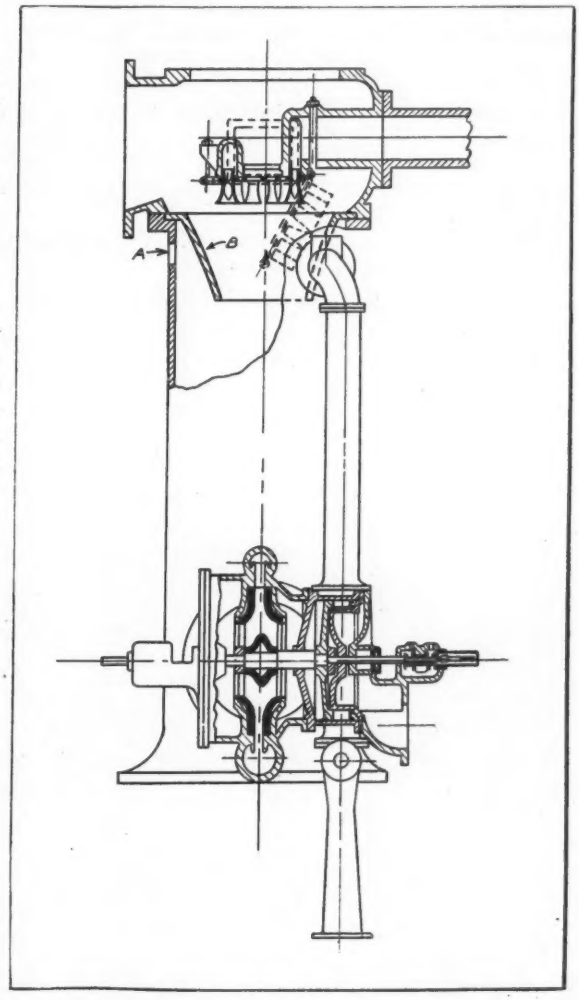
IN THE plant of the W. Va. Tract. & Elect. Co., Morgantown, W. Va., is installed a Westinghouse low-pressure turbine of 500 kw. capacity exhausting into a Le Blanc condenser.

As this plant is located on a small creek on which a templet mill is also located, the water, especially in dry weather, becomes very bad with acid from the mill and makes short work of the usual condenser pumps.

It was finally agreed to get rid of some of the trouble by installing a dry vacuum pump to replace the air pump furnished with the condenser. The new air pump required an 8-in. suction and then began the problem where to connect it in order to reduce to a minimum the amount of moisture carried over by the air.

The old air pump connection was an 8-in. opening, but as the vacuum breaker was connected on at this point it was not thought best for the safety of the turbine and new air pump to cut it out.

The problem was finally solved by connecting as shown at A, Fig. 1. The LeBlanc condenser is made with an inverted cone or funnel just under the spray nozzles (B, Fig. 1), so the hole for the new air connection was placed as far as possible up behind this cone. The connection was made by taking an extra heavy 8-in. pipe flange and having a saddle planed out of it to fit the curvature of the condenser body.



SHOWING CONNECTION OF NEW AIR PUMP

Then came the problem of connecting up with as little interruption as possible, as the turbine could only be shut down on Sundays and occasionally Saturday afternoon.

First the pump was got in running order, the line run to the condenser and the exact place marked for the connection and, as the thickness of the condenser body was one inch, a man was put to work drilling holes ¾ in. deep around the 8-in. circle where the connection was to be made. This was done by putting a piece of pipe over the drill, allowing only ¾ in. to protrude. The bolt holes for the flange, which had also been marked, were drilled to the same depth and tapped out for stud bolts. On shutting down, Saturday afternoon, the

holes around the 8-in. circle were drilled the other ¼ in., the piece removed, a ⅛-in. gasket heavily coated on both sides with thick black paint was put on and the flange bolted on, after which more of the paint was put on around the edge of the flange. When the vacuum pump was started not a sign of an air leak was found at this connection.

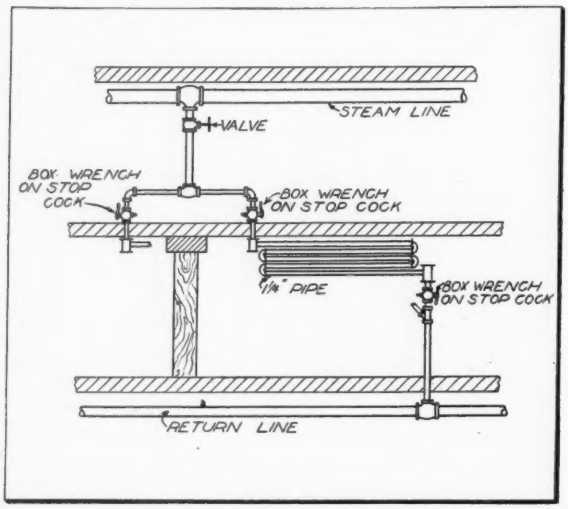
The air pump is further protected from any moisture that may be carried over with the air by ½-in. check valves on each end of the air cylinders.

The water jacket on the air cylinder is also protected from any chance of bursting pressure by the use of a ¾-in. low-pressure relief valve of the weighted type at the outlet from the jacket, which relieves the pressure in case the valve on the discharge line to the feed water heater accidentally be closed.

The chances of a breakdown from bad water have not only been lessened, but the vacuum has been raised about 1 in., which is quite an item in the operation of a low-pressure machine. E. C. Bowman.

Using Brine Coils for Low-Pressure Heating

In a large manufacturing plant, it became necessary to install heating apparatus on one of the floors on short notice, so short that there was not time to choose the form of heating equipment to be used, as heat must be supplied at once to prevent damage to incoming material. It happened that the storage rooms, which were



CONNECTIONS OF BRINE PIPES TO STEAM AND RETURN MAINS

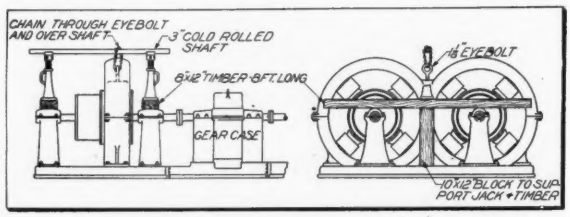
to be heated, had been previously used for cold storage and the brine pipes, placed near the ceiling, were still in place, but disconnected from the brine circulating system. There was a high and a low-pressure steam main at one end and a low-pressure return main at the other end of the room. Without delay, the tube cleaner hose was connected to the high-pressure steam main and to each coil of pipes in turn to blow out the scale accumulation in them, and then the pipe coils were connected to the low-pressure steam main and low-pressure return line, even using, in some, the old brass brine cocks for valves to shut off the steam. The change was made and the pipes tested out in less than half a day. It was at first thought that the old piping would not stand the pressure; but it was found that the heating surface of the coils was more than sufficient to supply the rooms with heat, and as the circulation was good, a low steam pressure was sufficient, 4 lb. being used on the extremely cold days, with all the coils in use; while, on moderately warm days, some of the coils were shut off, thus reducing the amount of heat supplied to the rooms. This system saved much time and labor in construction and the cost of a new installation of radiators and piping, as well as furnishing radiating surface sufficient to raise the temperature to 100 or 120 deg. if desired. This system of brine pipes was comparatively new, having been used only a few years, and with calcium brine the pipes did not rust out so badly at the joints as if salt brine had been used in them. There are few plants where heat and refrigeration are used extensively throughout the buildings; but often, old systems of one kind can be used to good advantage in other systems of operation if the equipment is in fair condition. The diagram illustrates the method of connection to the steam main.

R. A. Cultra.

Handling Machines in Small Space

Having read the article on the subject of assembling large sized generators, by Norman G. Meade in a recent issue of Practical Engineer, I concluded it might be of interest to your readers to hear of a recent job of similar character.

In his article, Mr. Meade assumes an unlimited amount of side and head room, while in this particular job the distance from the top of the generator to the ceiling was 4 ft. and the greatest amount of working space on any side amounted to 4 ft. and at some points only 1½ ft.


CHAIN THROUGH EYEBOLT AND OVER SHAFT
3" COLD ROLLED SHAFT
1½" EYEBOLT
6"x12" TIMBER 8FT. LONG
GEAR CASE
10"x12" BLOCK TO SUPPORT JACK & TIMBER

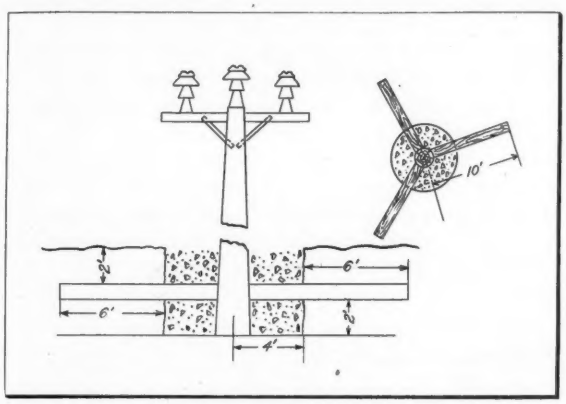
METHOD EMPLOYED TO REMOVE LOWER HALF OF GENERATOR FRAME

The unit consisted of a De Laval twin turbo-driven generator of 200 kw. capacity and it was necessary to remove the bottom half of each generator frame. As may be seen by the accompanying sketch, the upper half of the frame was raised sufficiently high to allow swinging it over the gear case of the turbine by raising it with a chain wound around a 3-in. shaft, supported by 2 jack screws, which rested on timbers placed across the main bearings and re-inforced in the center with blocking. When raised to a height of about 6 in. the frame was supported by the necessary blocking, planks and rollers to allow its being rolled sidewise up to the gear casing, the frame was again jacked up to a sufficient height to allow rolling it over to the desired position.

After this was done it was a simple matter to raise natures by means of the jacks also, to a sufficient height so that the lower half of the frame could readily be slipped out onto the floor. M. B. Hauke.

To Prevent Poles from Leaning

A HIGH tension transmission line, which ran through a swampy place, caused considerable trouble on account of leaning over considerably after a wet spell. The trouble was remedied in the following manner, guys not being allowed permanently on the poles. I secured strong rope long enough to guy the pole from 3 points, then dug out the dirt 4 ft. radius and down to the



FOOTING FOR TRANSMISSION LINE POLES IN SWAMPY GROUND

end of the pole, then 2 ft. from the bottom of the hole I placed a plank at 3 points, extending out 10 ft. from the pole. This hole was then filled with cement and no trouble was experienced afterwards, the cement acting as a ballast and the planks counteracting any tendency of the pole to lean. This method proved very effective. G. L. M.

Packing for Rolls

THE QUESTION and answer, under this heading, which appeared in the issue of May 15, recalls to mind some roll experience I have had. In lard refineries, rolls are used for cooling the lard by the circulation of cool water through the first roll and brine or calcium through the second, the arrangement being about the same as that employed in the rubber rolls. On some rolls, the inlet pipe is extended down to within an inch or two of the bottom and the overflow or outlet is close to the top; but I do not think that this has much advantage over the style with just the plain connections, as the circulation must be complete for the rolls are continually revolving. The circulation should be controlled by the valve on the outlet so as to keep the drum completely filled with the cooling fluid.

When the screwed gland is used, it will generally be found that one gland has a left-handed thread and the other a right-handed. This is to prevent the gland from coming off, as it might otherwise do; but I have seen a gland stick to the inlet pipe and become so tight that the grip of the packing has been so great as to tear some of the pipe work away. To guard against this accident in the future, a clip was made of a piece of ¼ by 1-in. iron and one end fastened to the roll by means of a cap screw. The other end of the clip rested against one of the flat surfaces of gland nut. The pipes that extend through the stuffing boxes should be brass and the weight of the roll should not rest on them, but on regular bearings. As to the packing of this style of roll, I have never had any particular trouble. Skookum packing is very good, but any kind of first class packing will give good results. One precaution must be taken and that is to be sure that the pipe work and the rolls are in line. If the roll is small and the inlet and outlet pipes are used as the shaft, then some device or bracket must be put up to make the job rigid. I know of lard rolls that run over 2 yr. without repacking.

In the drawing in the May 15 issue, there is no provision made to prevent the roll from having a lateral motion. The lug or collar is in the wrong place on the inlet pipe. This collar should be at the back of the stuffing box instead of inside the drum. Perhaps this little oversight is the cause of the packing trouble.

A. G. SOLOMON.

The Steel Belt Flurry

EVERY ONCE in a while, now-a-days, comes a report from the other side of the Atlantic concerning the excellence of steel belts in comparison with leather belts and rope drives.

I am not opposed to steel belts. Rather, I am in favor of such a belt provided it actually can prove itself more efficient than belts and ropes when the latter are run under proper conditions.

In every instance that has fallen under my observation I note that the leather belt or rope displaced by the steel belt was run under high tension. Perhaps the tension was about as high, initially, as in the steel belt, and for steel belts it is certain that initial tension must be pretty high on account of the smooth and hard nature of the belt.

I therefore suggest that American belt users go a little slow before jumping into the use of steel belts. It would be better to wait a while longer until the steel belt has proved itself the superior of a modern slack-running leather or cotton belt. To my mind, the slack belt is the better. It does not require taking up year in, year out. Its lesser tension means less power loss in the bearings, and should the leather belt break it is easily spliced.

True enough, the steel belt must have advantages in less width, less weight and less creep; but in spite of those advantages, I would not adopt the steel drive too quickly.

Where ball bearing journals are used, it is quite possible that the steel belt overcomes the initial tension disadvantages on account of the frictionless character of the bearings. It is evident that if a bearing is absolutely frictionless, it does not matter how great the belt tension might be. The steel belt would then have the decided advantage of less creep and less windage.

As for ropes vs. steel belts, I do not doubt that the steel belt can show decided improvement in power saving; nevertheless, the rope drive is so convenient in so many different ways that it is in little peril of being immediately displaced.

I believe the steel belt will find its place, ultimately; but I would not advise anybody to let it excite him into action which he might later repent. N. G. NEAR.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Electrical Questions *

10. (a) What apparatus is usually placed on a single-phase generator panel switchboard?

(b) Make a sketch and explain the connections for such a panel.

11. Show how 2-phase current can be transformed to a 3-phase current, describing the type of transformer used.

12. (a) Explain the difference between power and work.

(b) What is the electrical unit of work?

(c) What is the electrical unit of power?

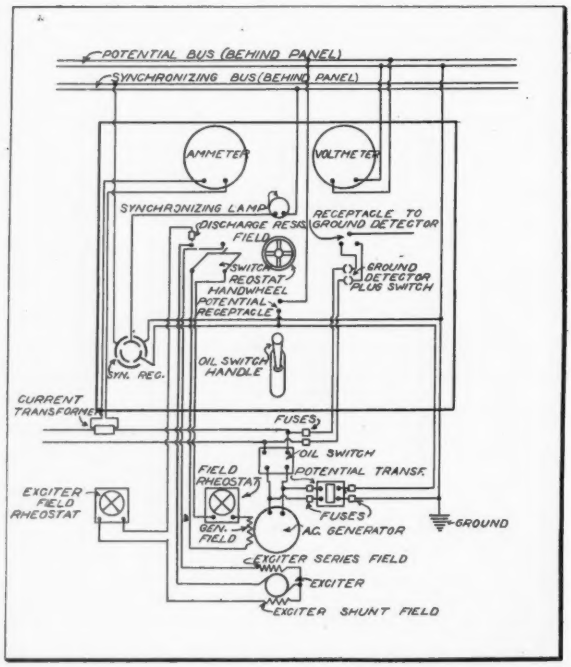


FIG. 1. WIRING DIAGRAM FOR SINGLE-PHASE GENERATOR PANEL

13. Six hundred 16-c.p., 110-v. lamps are operated at a distance of ¼ mile from the station by means of the 3-wire system. If the allowable drop on each side of the system is 5 v., what size of wire should be used for the outside wires and the neutral, assuming that the neutral is made ½ the size of the outside wires?

14. If a transformer is supplied with a primary e.m.f. of 1000 v., and has 1000 turns on the primary, how many turns must there be in the secondary to have an e.m.f. at the terminals of the secondary of 104 v.?

*Continued from p. 746, July 15 Issue.

15. A Thomson recording wattmeter when tested made 15 revolutions of the disk in 1 min. and 30 sec. If the constant of the meter was 2, what was the average number of watts expended in the circuit?

16. One thousand kilowatts are to be delivered over a line 5 miles long (one way) to a load consisting of motors and lights; 3-phase, 60-cycle system used; line loss to be 10 per cent of the power delivered; e.m.f. at end of line is 10,000 v. What size of wire should be used?

17. What is the approximate value of the line current required for a 10-hp., 3-phase, 500-v., a.c. motor?

18. A group of 100 16-c.p., 110-v. lamps are to be supplied with current by the 2-wire system, at a distance (single) of 400 ft. from the center of distribution, the allowable drop is to be 2 v. What size of wire should be used?

19. How can a cross on 2 line wires of circuit be located by means of the Varley loop test?

20. If a certain object is 20 ft. from a source of light, how many times will the illumination on it be induced if it is removed to a distance of 60 ft.?

S. S.

10. (a) One of the large electrical manufacturing companies furnishes the following in its standard equipment:

1 ammeter,
1 voltmeter,
1 field switch,
1 hand wheel for field rheostat,
1 synchronizing receptacle,
1 synchronizing lamp,
1 potential receptacle,
1 ground detector receptacle and plug,
1 ground detector plug switch,
1 handle for oil switch.

Where there are several generator panels controlling generators of the same phase and voltage, the voltmeter and ground detector apparatus are omitted on all but one. See Fig. 1.

(b) When the 2 contacts on potential receptacle are connected, the voltmeter is placed across the potential transformer terminus. When the synchronizing receptacle is closed, the potential transformer is connected in series with the synchronizing lamp across the synchronizing bus. At some place not shown, the synchroscope is connected to synchronizing bus. When the ground detector switch plug and the receptacle plug are in, one line is connected to ground detector. When the double-pole switch is being opened, the discharge resistance is in series with the shunt field of exciter, preventing the field from being burned out. The rheostat

handle is connected to field rheostat shown between panels. The oil switch handle controls the oil switch shown in the diagram.

11. Scott's transformer consists of 2 cores, 1 phase of the 2-phase side being wound on each core, as shown in Fig. 2.

One secondary is made up of 2 parts, a and b, of equal number of turns. The other secondary, c, is made up of 1.73 times the number of turns in a or b. One side of winding c is connected to the point between windings a and b.

The free terminals for windings a, b and c deliver 3-phase current. (See accompanying sketch.)

12. (a) Power is the rate of doing work, while work is production of motion against a force tending to resist it.

(b) The practical electrical unit of work is the watt-hour; the practical electrical unit of power is the watt.

13. Assume lamps to be 60-w. each, half the lamps being on each side of the system.

$300 \times 60 = 18{,}000$ w. on each side of system.

$\frac{18{,}000}{110} = 163$ amp. flowing on each outside wire.

$R = \frac{E}{I}$, where

R = line resistance.
E = volts drop.
I = current flowing.

$R = \frac{5+5}{163} = \frac{10}{163} = 0.061{,}35$ ohms.

Length of circuit $= 2 \times \frac{1}{4}$ mile $= 2640$ ft. $= 2.64 \times 1000$ ft.

Resistance per 1000 ft. of outer wires $= \frac{0.061{,}35}{2.64} =$ 0.023 ohms.

Consulting a wire table, 450,000 C.M. cable has about this resistance: No. 0000 wire has about ½ the resistance, so we select 450,000 C.M. cable for outside wire and No. 0000 wire for the neutral.

14. $\frac{Es}{Ep} = \frac{Ns}{Np}$. Where Es = secondary voltage. Ep = primary voltage. Ns = number of turns in. Np = number of turns in primary.

or

$Ns = Np \times \frac{Es}{Ep}$.

Substituting, $Ns = 1000 \times \frac{104}{1000} = 104$ turns.

15. Meter watts = (3600 × constant × rev.) ÷ sec.
= (3600 × 2 × 15) ÷ 90
= 1200 watts.

16. Assume generating and receiving ends of circuit to be Y connected.

Equation of power in 3-phase circuit is,

$P = \sqrt{3}\,EI \times P.F.$, or $I = \frac{P}{\sqrt{3}\,E \times P.F.}$.

Where I = current in each main;
P = watts delivered;
E = line voltage at receiving end;
P.F. = power factor of the circuit. This should be given. Assume it to be 0.85.

$I = \frac{1{,}000{,}000}{1.732 \times 10{,}000 \times 0.85} = 68$ amp.

Watts line loss = 10 per cent of 1,000,000, or 100,000.

$W = \sqrt{3}\,I^2R^1$, where
W = watts line loss and
R^1 = approximate line resistance of each main.

$R^1 = \frac{W}{\sqrt{3}\,I^2} = \frac{100{,}000}{1.732 \times 68 \times 68} = 12.5$ ohms.

Voltage drop $E^1 = \frac{W}{\sqrt{3} \times I}$.

$Eo - E = \sqrt{3}\,R^1\,I$, where Eo = voltage of line at generating end.

$Eo = \sqrt{3}\,R^1\,I + E = 1.732 \times 12.5 \times 68 + 10{,}000 = 11{,}475$ v.

The approximate resistance per mile is $\frac{12.5}{5} = 2.5$ ohms. From table of Resistances and Reactances, the resistance of No. 6 wire is 2.088 ohms per mile. Therefore, No. 6 is the approximate size wire required.

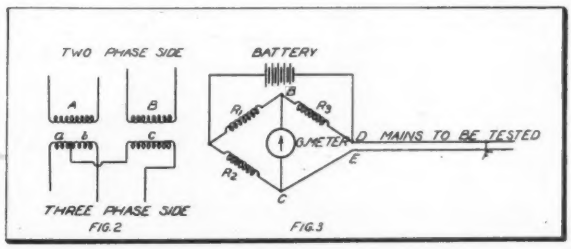


FIG. 2. WIRING DIAGRAM OF SCOTT TRANSFORMER
FIG. 3. VARLEY'S LOOP TEST FOR CROSSES

The spacing of conductors is not given. Assume it to be 18 in. Consulting the table of Resistances and Reactances, the reactance X of No. 6 wire at a spacing of 18 in. and frequency of 60 cycles is 0.685 ohms per mile. Considering one main as one side of the circuit, and the other 2 mains together as the other side of the circuit, the reactance of the double 5-mile line is 6.85.

For circuits with Y connected transformers at both generating and receiving ends, the formula for true line resistance may be stated as follows: Square the station voltage; multiply transformer terminal voltage by 0.866 and by the sine of angle of lag between current and e.m.f.; square the product of this continued multiplication and subtract from the first square found; from this remainder substact the transformer voltage times the power factor (which is the cosine of the angle of lag); extract the square root of the final remainder and divide that root by 1.732 times the current. Angle of lag, *a* is found from a table of cosines, knowing the power factor, and sine *a* from a table of sines, knowing *a*.

Expressing the above formula in the form of an equation and substituting the proper values, we have

$$R = \frac{\sqrt{(11{,}475)^2 - (10{,}000 \times 0.525 + 0.866 \times 1.732 \times 68)^2 - 10{,}000 \times 0.85}}{14.15} =$$

14.15 ohms, or $\frac{}{5} = 2.83$ ohms per mile.

From Resistance and Reactance Table, No. 7 wire has a resistance of 2.633 ohms per mile. This, therefore, is the approximate size wire to use.

17. The equation for power is,

$P = \sqrt{3}\,E\,I$. Where,

P = watts power,

E = volts across mains,

I = currents in each main.

Then $I = \frac{P}{\sqrt{3}\,E}$.

1 Hp. = 746 w.

10 Hp. = 7460 w.

Substituting, $I = \frac{7460}{1.732 \times 500} = 8.6$ amp.

18. Assuming the lamps to be 60-w. carbon lamps, and the circuit to be d.c.

The power = 6000 w.

Current $I = \frac{6000}{110} = 54.5$ amp.

Voltage drop $E = I\,R$, where R is line resistance in ohms.

$R = \frac{E}{I} = \frac{2}{54.5} = .036$ ohms for 800 ft. wire.

Resistance for 1000 ft. wire $= \frac{1000}{800} \times .036 = .045$ ohms.

From a copper wire table we find No. .0000 B & S wire has a resistance of .049 ohms per 1000 ft. and No. .000 B & S wire has a resistance of .061 ohms per 1000 ft., therefore it would be best to use that wire having the lowest resistance, or the No. .0000.

19. Connect up Wheatstone Bridge as shown in Fig. 3, with galvanometer between points B and C. Connect battery to points A and D. Connect one main to point D and the other main to point E. Consider F as the point where the cross is.

In leg A B, resistance is R_1.

In leg A C, resistance is R_2.

In leg B D, resistance is R_3.

In leg C D, resistance X is to be determined.

X is the sum of the resistances of the mains to the cross.

Adjust resistances till the galvanometer has no deflection.

Then $\frac{R_1}{R_2} = \frac{R_3}{X}$.

$R_1\,X = R_3\,R_2$.

$X = \frac{R_3\,R_2}{R_1}$.

By substituting the known values of R_1 R_2 and R_3 in the above equation, the resistance X is found.

Knowing size of mains, find from a wire table the resistance per foot. Assume the 2 mains to be the same size wire.

Then the number feet distance O to the cross $F = \frac{X}{2 \times \text{resistance per foot.}}$

In other words, the resistance just found divided by twice the resistance per foot of the main gives the number of feet to the cross.

20. Illumination varies inversely as the square of the distance from the source of light.

$\frac{60}{20} = 3$.

Then at 60 ft., the illumination is $\frac{1}{3 \times 3}$ or 1/9 of that at 20 ft.

W. N. S.

Blowing Down

IN BLOWING down a boiler into the sewer, how much pressure would you use?

A. A boiler should not be blown down under any pressure directly into the sewer. If blown into a suitable blowoff tank, it may be blown down one or 2 gages at working pressure. It is a bad practice to blow all the water out of a boiler under any steam pressure for several reasons. This practice will cause sudden and unequal contraction, which may start a leak or lap seam crack, also any scale or mud not blown out—and very little of it will be blown out—will bake onto the shell and tubes, making cleaning much more difficult; and blowing into the sewer, even at low pressure, may cause the sewer to leak or to blow back through the nearby toilet-room fixtures. The boiler should be allowed to become thoroughly cool before emptying. If, however, it cannot be spared long enough, or must be emptied at once, it can be blown down at a pressure not to exceed 10 lb., although less would be better.

Boiler Seams

HOW WOULD you figure the ligament and girth seam in a Worthington boiler?

2. Explain why girth seams need be only half as strong as longitudinal seams.

3. Explain how to patch a girth seam on a horizontal return-tubular boiler and not reduce efficiency.

4. What are the objections to making longitudinal joints over 12 ft. long?

5. In designing joints, why are they not made to be equal in strength between rivet holes, and in crush and in shear?

J. A. M.

A. There are no girth seams on Worthington boilers; 2 head seams only. The ligament is figured the same as a joint; that is, patch of tubes, from center to center of tube holes, minus diameter of tube, divided by pitch, equals net section. Head seams are calculated the same way.

2. To illustrate: Take a boiler 14 ft. by 66 in., and having ⅜-in. plates with a tensile strength of 55,000 lb. The bursting pressure of a ring of metal (without a joint) from this shell would be $0.375 \times 55{,}000 \div 33 = 625$ lb. The circumference of the ring is 207.3 in., and the area, 77.74 sq. in. When the ring breaks, the strain on it will be $77.74 \times 55{,}000 = 4{,}275{,}700$ lb. Acting lengthwise is the pressure on the head, which is equal to the pressure per square inch times the area of the head, which, in this case, is 3421 sq. in. When the ring or shell parts, the strain on this section must be such that, by acting on this area, it will produce a resulting strain of 4,275,700 lb., which gives us ($4{,}275{,}700 \div 3421 = 1250$ lb.), exactly twice the amount of the first.

3. Use a girth patch, which should not be placed over 6 in. from the original seam; make the ends of the patch slope to the original joint at an angle of 55 deg.

4. As the horizontal seam is the weakest part of the shell, and the girth seam has a stiffening effect which is of considerable importance on the score of safety, a girth seam at intervals is advisable. The stiffening effect is found to be dependable up to 12 ft.

5. All authorities allow an excess of rivet strength over the net section of plate on account of the possible sliding of the plates. This also prevents the crushing of the metal between the rivet holes and the edge of the plate.

Boiler Compound

In one of the late issues of Practical Engineer, I noticed a receipt for boiler compound using the following ingredients: 5 lb. catechu, 5 lb. salammonide, 50 lb. sal soda and 48 gal. of water.

Kindly tell me how much of this compound to feed each 24 hr. per 100 hp. of boiler capacity.

Will too much of this compound cause the boilers to foam?

Where may catechu be obtained?

R. R.

A. As you perhaps know, the quantity of boiler compound to be used per day of 24 hr., in a boiler of given size, depends a great deal on 3 things:—

1. The quality of the water.
2. The rate of evaporation.
3. Whether a heater or purifier is used.

In the marine service, and especially if the steamer is engaged in interlake traffic, the quality of the water is changing constantly, as the water in each one of the great lakes is different from that in the others; and, while in the several ports, the water from the rivers is still different, depending on the nature of the country through which the river flows. Thus it is entirely possible for a boiler to use water that is comparatively soft, one day, and the next to use water that flows from some river having its source in a country where limestone is abundant and the scale content nearly doubled.

Then, again, water may be used while in port that is charged with a chemical used in some factory or mill in the process of manufacture, and emptied into the river. This ingredient may, in itself, be an antidote for the scale evil.

Of course, the greater the rate of evaporation, the greater will be the scale deposit. And if a boiler be forced excessively, the scale seems to form quicker and is harder than if the same quantity of water were evaporated in a boiler somewhat larger, so that it will not be subjected to forcing.

If a live steam purifier be used, and the conditions are anywhere near right, the scale entering the boiler is practically nothing as it is all collected in the purifier. In a case of this kind, no compound, or at least a very small quantity, is necessary. The writer is familiar with a battery of return tubular boilers using a purifier for 16 yr., and although there has never been an ounce of compound used, the boilers are absolutely clean, and have never had any repairs due to water impurities.

An open heater where the water can be heated to a temperature equal to the back pressure, will remove a great deal of the scale forming matter, and thus reduce the quantity of compound that would otherwise be required. Generally speaking, a closed heater removes little if any of the scale solids, and this small quantity in adhering to the tubes, etc., reduces the efficiency of the heater, and requires an increase in the compound used per boiler horsepower.

Averaging the conditions in your inquiry, however, and striking a happy medium, we would say that about a quart of your compound would be the right quantity to use. Of course, one must watch operating conditions closely, and especially so if the design of the boiler is such that the loose scale will lodge where damage to the boiler will result.

If, upon examination of the boiler inside, the scale is not loosening as fast as it should, increase the quantity slightly, and vice versa.

This compound is liable to cause slight foaming if used in excess or if the water is impregnated with oily or fatty matter. Sometimes the water in a river or "slip" near a packing house or tannery, will be so impregnated with these substances as to cause excessive foaming even without compounds containing sodas.

Catechu can be purchased in the larger drug stores, and sometimes in marine supply houses.

G. H. Wallace.

"Setting a river afire" is no longer such an absurdity as the coiner of the old phrase intended. A fire surrounded by water, above below and on all sides, merrily burning and churning the water to steam, is a recent accomplishment, the trick being to start a flame of gas or oil vapor mixed with the right amount of air and shooting downward under pressure from an orifice into an empty tank. Then gradually fill the tank, keeping sufficient pressure on to force the flame and hot gases out into the water; and, Lo! steam and gases are shortly escaping into a storage tank, with maximum absorption and retention of heat. Not, perhaps, practical, for thousands of horsepower, but an interesting triumph of mind over matter, and likely to be useful in many operations.

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Trend of the Times

Up to the last few years the chief engineer was a man whose knowledge of engines and turbines was of primary importance and whose first duty it was to see that he had and maintained a well organized working force. Every thing was kept, or supposed to have been, in first class operating condition and in order to carry the "ship through calm and storm" it was necessary to engage a more or less high priced man.

As stated, the chief's ambition was to have things in tip top shape as far as the engines, turbines, pumps and even the boilers were concerned, and he cared little about the nature of the fuel used out in the stoke-hole or in what manner it was fired. As long as it was fired, and as long as the gages showed a sufficient amount of pressure the head of the plant was well at ease and it was not for him to worry and wonder why.

Worry and wonder about what? That question slowly became answered as industrial and commercial competition became greater and the cry for efficiency arose and was carried to the dark and sooty corners of the world's power plants. It did, however, not fall on deaf ears, and the engineering fraternity sat up and heeded the cry. It realized something must be done to operate the plant more economically and efficiently.

The engine room was running, and running as well as mankind could make it, but waste was lurking under and around the furnaces of the boiler room, eating up, day in and day out, from month to month and year to year.

Engineers have realized their predicament and set about to correct the evil conditions, and after careful study and hard labor they have attained a high standard of economy and efficiency, but which will increase from year to year.

How does this change affect the operating man? It demands of him a thorough knowledge of boilers and furnaces and their successful operation; it takes him from the engine room to the boiler room and impresses upon him the fact that this is also his place; it has increased his earning power and, above all, has tended to make a better man of him by requiring him to think, act and economize.

ARRANGEMENTS ARE UNDER WAY for the construction at the Panama-Pacific Exposition of a mine beneath the floor of the Palace of Mines in Metallurgy, in which there will be shown, by full sized working places, with the proper mining machinery, and with the walls covered with the ore or coal typical of the mine illustrated, the operation in gold, silver, coal, and other mines, with the drills, coal cutters, air compressors, hoists, etc., as actually used in mine work. The entrance to the mine will be through the U. S. Bureau of Mines' space, and by means of a cage which, as it is slowly lowered, will show the strata lining of a mine shaft.

Another entrance will be by means of a slope for crowded times. The exit will be by a slope in the radium exhibit of the Bureau of Mines. Various mining companies and manufactures have agreed to furnish machinery and make installations, so that the success of the project is assured.

News Notes

THE STATE-CENTER ELECTRIC CO. is completing a $100,000 plant at Milesburg, Pa., with which to supply light and power to about ¼ of Centre County.

VILTER MFG. CO., Milwaukee, Wis., has removed its Chicago District Office from 802 to 731 Monadnock Building, where C. J. Heinzelman will continue as district manager.

THE STRIKE of the Westinghouse workmen, at East Pittsburgh, was called off by the men on July 9, and while the day set for the return to work was July 13, a large number reported on Friday and Saturday, the 10th and 11th. The works are now running full time.

HARRY J. MARKS, manager of the New York office of the American Engine & Electric Co., has been advanced to the position of sales manager of the company. Mr. Marks is a member of the American Society of Mechanical Engineers, and numerous other engineering societies, and has had about 20 yr. active experience in the operating, manufacture, design and sale of steam engines. He will divide his time between the New York office, 90 West St., and the main office of the company, which is located at Bound Brook, N. J.

MEETING OF THE AMERICAN Peat Society will be held in Duluth, Minn., August 20 to 22, in the rooms of the Commercial Club. Papers will be read covering the Work of Handling Peat Swamps, the Converting of Peat into Fuel, and the Use of the Fuel for Different Purposes.

In connection with the meeting, there will be a trip to the iron mines of the Missabe Range, and to experimental farms, showing the use of peat bogs for agricultural purposes. There will also be an exhibition of peat, its products, and machinery for handling it. Further information can be had from Julius Bordollo, Kingsbridge, New York City.

FREDERICK O. BALL announces his resignation as general manager of the American Engine and Electric Co. (formerly the American Engine Co.), of Bound Brook, N. J., on July 1, 1914. He leaves the engine business to engage in the manufacture and sale of carburetors with his father, Frank H. Ball, who retired from the engine business last year. The carburetor business will be conducted under the firm name of Ball and Ball, with Headquarters in Detroit, Mich.

U. S. CIVIL SERVICE COMMISSION announces an open competitive examination for heating and ventilating engineer, on Aug. 5 and 6, 1914, to fill a vacancy in this position at $1800 a year in the United States Military Academy, West Point, N. Y. The appointee should be thoroughly familiar with direct and indirect heating of large buildings; the thermograde and thermostat systems of regulation; the operation of motor-driven fans; steam fitting; regulation of reducing valves, steam traps, etc. Competitors will be examined in the following subjects, which will have the relative weights indicated: Practical questions in heating and ventilating (involving a competent knowledge of mathematics and plumbing, and of heating and ventilation of buildings, both theoretical and practical), 35; drawing and design (involving ability to design and draw plans, etc., for the heating and ventilating plants of modern public buildings), 35; training and experience, 30. Eight years' experience in the design, installation, or operation of heating and ventilating plants is a prerequisite for consideration for this position. A technical education in engineering will be considered equivalent to not more than 4 yr. of these. Age, 25 yr. or over on the date of the examination. In applying for this examination, ask for Form 1312, using the title, Heating and Ventilating Engineer (Male).

THE WESTINGHOUSE MACHINE CO. reports the receipt of an important contract calling for the manufacture of 9800 ft. of 36-in. flexible-jointed, cast-iron submarine pipe, to be used in connection with the New York City water supply, forming a siphon under the Narrows in connection with the water supply brought from the Catskill aqueduct and carried to Staten Island. The siphon will extend from the terminus of the pipe line from 79th St. and Shore Road, Bay Bridge, Brooklyn, to the junction of Arrietta St. and Stuyvesant Place, Staten Island.

In order to lay this pipe, which will weigh approximately 3800 tons, it will be necessary to dig a trench across the Narrows, which, on account of the dense traffic, will be a difficult job, as the specifications insist that no more than 1000 ft. of channel may be obstructed at any time.

Further difficulties in the laying of this pipe are afforded by the tides, currents and great depth of water, and the total excavation necessary.

Experiments made by the City of New York with 36-in. flexible-jointed pipes have proved that such joints are water-tight before, during and after deflection under water pressure up to 2000 lb. per sq. in. and give every promise of being acceptably tight joints without the necessity of submarine calking. This method of stopping joints has therefore been made an extra item in the contract.

Essential features of the flexible joints are: The flexible bell turned on the interior, reinforced by a band of wrought iron, set, shrunk, or pressed on; a spigot having a tap grooved for the retention of the lead; a narrow turned collar to bear on the bell in order to insure uniform leaded space to carry the weight. The average laying length of the pipes is to be at least 12 ft.

The pipe is to be coated inside and outside with a bitumastic solution, or bitumastic enamel. Before the first coat has been applied, each pipe shall be subjected to a hydrostatic pressure of 350 lb. per sq. in., and to a hammer test under this pressure. The angle of maximum deflection of the joint is to be 10 deg. 50 min.

When the pipe has been finished, it will be shipped to New York and loaded on barges, from which it will be lowered into the water in sections. The pipe will be cast at the Trafford City foundry of the Westinghouse Machine Co., and the machine work, of which there is a considerable quantity, will be performed at the East Pittsburgh works of this company.

THERLOW STEEL & FORGING CO., of Chester, Pa., has recently placed in operation its plant for the manufacture of forgings from 1 to 10,000 lb. This includes steam hammers, a 1000-ton forging press, heat treating plant, and machine shop for rough and finished work.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Safety Applications of the Swing Gate Valve

By Oscar C. Schmidt

ONE of the most important safety devices used to prevent disaster to the steam turbine, steam engine, steam pump, steam hammer, steam elevator, and other types of steam and hydraulic apparatus is the swinging gate and check valve. This type of valve acts as a safety valve on any pipe line where it is necessary that the flow through the pipe shall be in one direction, and where disastrous effects would follow if the medium were allowed to flow into the pump or engine cylinder in a direction contrary to the normal flow.

Besides the safety which is required, it is also often necessary to take away from the current of the water or steam, the checking device, thus allowing continuity of flow without any restrictions which would cause back pressure, or allow sediment to collect, as well as permitting the current to be reversed under pressure.

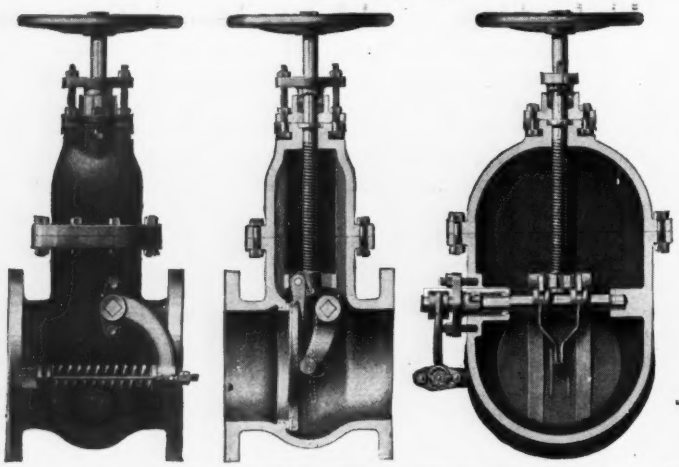


FIG. 1. VIEWS OF NELSON ERWOOD SWING GATE VALVE

The ease with which these advantages of safety and operation are attained by one piece of apparatus is clearly shown in Fig. 1, which represents the Nelson-Erwood swing gate valve. It embodies the features of a gate and check valve in one, and is capable of performing the functions of either. The action of the swing gate is controlled by a spring, outside of the valve casing, the tension of which is regulated by the pressure desired. The action of the gate valve is controlled by the hand-wheel, which raises the gate above the valve opening, thus giving a straightway opening, with no obstruction in the pipe. The face of the gate and the seat ring are flat, both being made of bronze. The valve is always positive in its action, as the gate and seat are self-cleaning by the action of raising and lowering the gate, which will wipe or shear off any foreign matter which would otherwise prevent closing.

One of the most interesting applications of the swing gate valve for safeguarding the usual compound engine plant, is shown in Fig. 2. Not only do these valves permit the operation of either cylinder singly, but they also allow cross-condensing or noncondensing. The swing gate valve A protects the high-pressure cylinder; the valve B closes the receiver from the atmosphere; the valve C acts as an automatic relief between the condenser and low-pressure cylinder; the valve D acts to prevent any water from flowing from the condenser into the low-pressure cylinder. Such an arrangement positively safeguards the engine from any possible action which may be caused by operating conditions or negligence of operation.

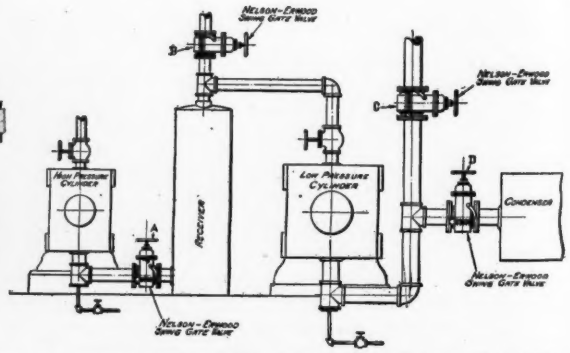


FIG. 2. SWING GATE VALVES USED TO PROTECT A COMPOUND ENGINE

The application of this safety principle to a single noncondensing engine is shown in Fig. 3.

The swing gate valve is also useful for the prevention of accidents in pump service. When cutting a pump in or out of service, it is generally necessary to close 2 valves of the steam side, and 2 valves on the water side. When the swing gate valve is installed in place of the usual valves, any pumps can be readily cut in or out of service by operating the throttle valve. As the steam starts the pump, the swing gate valves open accordingly. If the pump is to continue in operation any length of time, the swing gate valves can be thrown out of service if desired by the operation of the handwheel, as in an ordinary gate valve.

When used as a back pressure valve, on an open heater or exhaust system, it may be placed in any position, and it can be thrown in or out of service without changing its adjustment, and it may be placed in any exposed position.

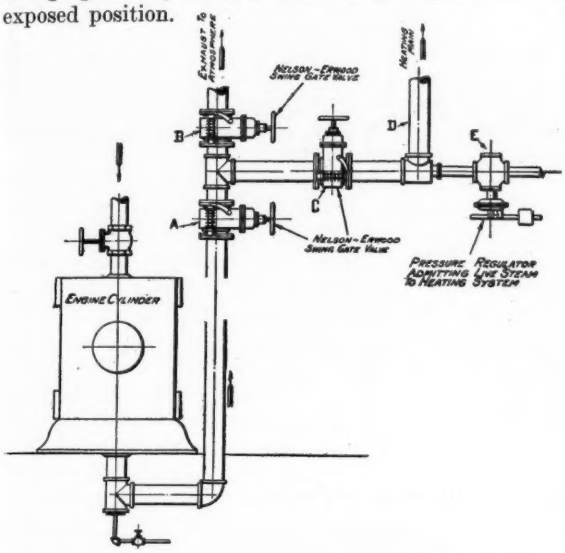


FIG. 3. USE OF SWING GATE VALVES FOR PROTECTING NONCONDENSING ENGINE

In steam turbine practice, the swing gate valve has particular application when low pressure or mixed flow turbines are used. Valves are placed between the low-pressure inlet to the turbine, and the engine exhaust piping, in order to prevent vacuum backing up into the exhaust piping and drawing in air through leaks and through the piston rod and valve stem packings. The swing gate valve is so set that whenever the pressure in the engine exhaust piping falls below one pound above the atmosphere, it closes and remains closed until the pressure rises above this point.

Bristol's Pneumatic Type Recording Tachometer

IN many instances it is not convenient to have a recording tachometer installed in self-contained form and located near the revolving shaft. One of the special features of the new Bristol pneumatic type recording tachometer is the flexible connecting tube, 25 ft. long or longer, between the revolving mechanism and recording instrument, which is mounted in any convenient position, as, for instance, on a switchboard or the wall of engine room.

The pneumatic principle of operation depends on the centrifugal action of air in a revolving tube, which is connected on the recorder through a special oil seal and flexible connection tube.

Figure 2 shows diagrammatically the construction of the revolving mechanism. In the diagram, B designates a hollow circular protecting base, and at its upper surface is provided a bearing for a hollow shaft, D. This shaft is arranged to be rotated from any desired mechanism through a set of gears and pulleys (or sprockets).

A pulley, C, is shown, over which a belt runs to a similar pulley attached to the shaft, whose revolutions are to be measured and recorded. In practice, most of these tachometers are being furnished with special form of sprocket and chain instead of pulley and belts.

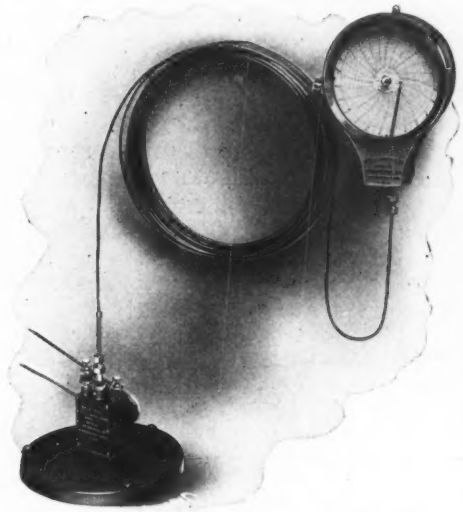


FIG. 1. COMPLETE PNEUMATIC TACHOMETER OUTFIT

The lower end of the hollow shaft, D, terminates in a horizontal tube, A, open at its extremities. The upper end of the hollow shaft is surrounded by a casing, E. It is partly filled with oil and into this extends the free end of another tube, F. The tube F is stationary and is joined at its outer end to a flexible capillary connecting tube, G, leading to the recording instrument.

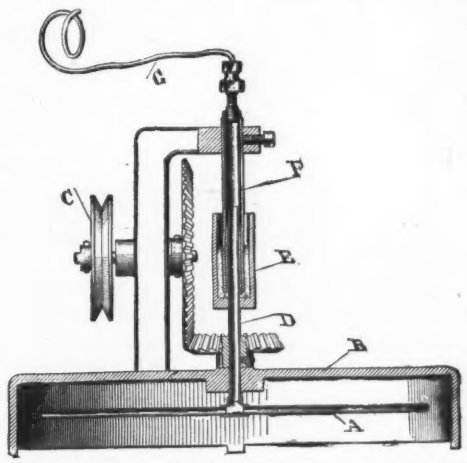


FIG. 2. CONSTRUCTION OF REVOLVING MECHANISM OF PNEUMATIC TACHOMETER

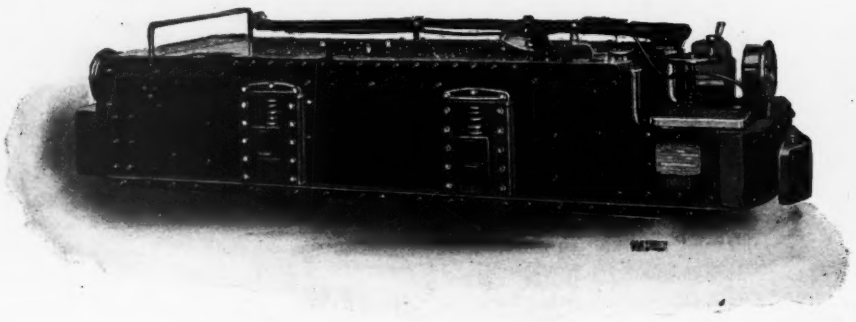
The recorder used with this patented speed measuring device is a special low range Bristol recording vacuum gage. The recording instrument may be installed either near to or at a distance from the shaft or engine, the speed of which is to be recorded, and a suitable length of flexible copper tubing is furnished to connect the recorder with the revolving tube.

These patented tachometers are manufactured by the Bristol Co.

Pioneer Electric Locomotive in Alaska

WHAT is claimed to be the first electric locomotive ever used in Alaska was placed in service within the past few months for mining operations by the Alaska Treadwell Gold Mining Co. at Treadwell, Alaska. This company was incorporated in June, 1889, under the laws of the State of Minnesota for the purpose of taking over the Paris mine and reduction works at Douglas Island, which had been operated since 1882 by the Alaska Mill & Mining Co. The mine is an immense low grade ore proposition, the property being equipped with 2 mills having a total capacity of 540 stamps, power plants, foundry, cyanide plant, machine shop, sawmill, central hoisting and crushing plant, etc., practically all of which are either operated by electric power or being equipped for electric drive.

The 2 initial electric mining locomotives are each of 6-ton capacity and are operated on a 500-volt direct-current circuit from an overhead trolley. They were manufactured by the General Electric Co. and are of the standard outside frame type, in which the side frames are placed outside of the wheels. Each machine is equipped with 2 motors having ball bearing armatures, the motors being mounted in tandem, whereby one motor is located in front of the rear axle and the other between the forward axle and the front end frame.



TYPE OF ELECTRIC LOCOMOTIVE AT THE MINES OF THE ALASKA TREADWELL GOLD MINING COMPANY

The motors are of the usual series-wound type and the controller is of the rheostatic magnetic blowout type. A commutating switch is incorporated in the reverse cylinder, the handle of which has 4 "on" positions, 2 for each direction of motion, 1 with the motors in series and the other with the motors in multiple. This system of control, by permitting the motors to be started in multiple, allows them to exert their maximum tractive effort independently, so that the slippage of one motor does not affect the other. With the series connections economy in current consumption is effected while running, for the locomotive will then develop a given drawbar pull with ½ the current required with the motors in multiple, the speed, of course, being reduced in approximately the same ratio.

The locomotives are operated on the track leading from the central shaft house to the various mills and haul ore trains composed of 10 or more trailers aggregating a gross trailing load of some 80 tons.

Eureka Improved Steam Trap

THIS is a direct working apparatus, the valve being kept closed by the weight of the float, and pressure on the area of the valve opening. When the water has arisen to a point where its buoyancy will lift the float, the valve is thrown wide open and water discharged, until the float drops and closes the outlet. The trap is always wide open or entirely closed, as the amount of condensation demands, and while discharging, a vortex is created that revolves the float with the water on which it rests, so that the valve and seat are reground at each operation. Sediment collects at the bottom of the trap, outside the valve seat, which extends upward, leaving a sediment chamber, and a drain is provided for drawing off sediment and scale.

On the top of the trap is an air cock for relieving air binding, and the entire top of the trap lifts off, leaving the interior freely exposed for any repairs or renewals. The presence of water at all times in the bottom of trap serves as a seal and also acts as a cushion when the valve closes, thus preventing jar. Between the top and bottom of the trap is a gasket fitted inside a rim, so that it cannot possibly blow out. High pressure traps have been found to work satisfactorily over long periods up to 175 lb. pressure, and low pressure traps as low as 4 lb. pressure. Above 175 lb., a special Eureka trap is made by Eureka Steam Trap Co., of Racine, Wis., which handles the entire line.

PHANTOM VIEW OF EUREKA IMPROVED STEAM TRAP

A COOLING TOWER, 22 ft. high, containing 7 floors made of common board, with each floor laid so that the centers of the boards composing it are directly beneath the edges of the courses above and below, has been very successful. The temperature of the water runs as high as 165 deg.; when the air is moist, this will be reduced to 95 deg. at the bottom of the tower, but when the air is dry, the temperature can be reduced to 80 deg. The tower has natural draft, with a 10 by 12-ft. splash boarding all around. A cloud of steam is found at the top of the tower, and in the 5000-gal. galvanized tank at the bottom the temperature will not run higher than 95 deg., even with the greatest humidity in the air.

Allan Metal Rings for Pistons

HEREWITH is shown a sectional view of a piston for a rail mill engine, showing the insertion of rings of Allan Metal to take the wear between piston and cylinder, and also detail sketches, showing the method of putting in the rings.

Dovetailed grooves at least ½ in. deep are cut around the piston or bull ring, the width of the grooves at the face of the piston being from 1 to 2 in., according to the amount of bearing surface on the bull ring, and ⅛ in. wider at the base of the groove, making 1/16 in. taper on each side. Three-quarters inch of stock should be allowed on each side of all grooves, and the grooves should never be over 2 in. wide, as better service will be secured by using more rings and of narrower width, as for instance, 2 1¼-in. rings rather than 1 3-in. ring.

Allan Metal castings are supplied in segments of proper radius, which are peened in rough state into the dovetailed grooves. For this reason, when the rings are ordered, the full dimensions of the grooves and the diameter of piston and number of rings should be given, so that the segments may be made to correspond.

In applying a segment, one end is laid in and peened about half an inch from the end of the segment, to stick it into the groove. A clamp is then placed at the other end of the segment, as shown in No. 2 of the perspective illustration, and the segment is peened along the center of its width severely several times, to force the metal down solid on the base of the dovetailed groove, and it is then peened thoroughly all over. The clamp is then removed, and succeeding segments applied in like manner, the first segment not being peened where the clamp was placed, until after the second segment has been

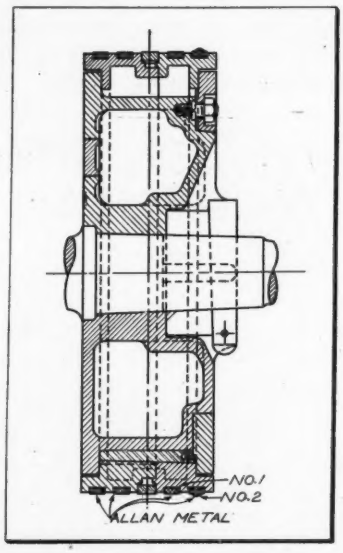


FIG. 1. SECTION OF PISTON WITH ALLAN METAL RINGS

peened along the center of its width. Then, peen the preceding segment at the point where the clamp was placed, and proceed to apply the following segment. The object of proceeding in this manner is to be sure that all points in the groove are thoroughly filled with the Allan Metal, and that there is no lengthwise stretching of the strip, which would leave insufficient metal to fill the groove.

When applying the last segment, care must be taken to have it complete the ring. As shown in No. 1 of the perspective view, the segment must be cut a little short, to allow for expansion due to peening, the amount cut off being determined by the expansion of the preceding segments. If the last segment has not room enough to expand under the hammer, it will loosen the preceding segments and make the whole application worthless. Heavy peening does not injure the metal, but by compacting it, adds to its wearing qualities. In turning off after peening, the metal should be given the same clearance as cast iron, and turned to the diameter of the cylinder. If the metal is not peened down solid, as shown in No. 1 of the sectional view, but is left with a

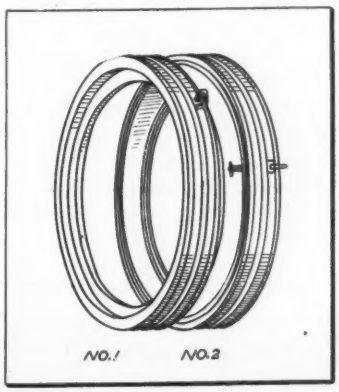


FIG. 2. PERSPECTIVE VIEW SHOWING METHOD OF APPLYING

hollow space under the base, as shown in No. 2, there will be a pressing down after the piston is put into service, indicating a wear that does not exist.

With the rings properly applied and turned off, there is produced a wearing surface of antifriction metal to bear against the cylinder walls, thus avoiding scoring and reducing friction. The material can be secured from A. Allan & Son, of New York City.

Improved Laboratory Portable Meter

D'Arsonval Principle Employed But With Single Air Gap

THERE has been a logical demand for a line of laboratory standard instruments, approaching in accuracy the meters of the precision type, suitable particularly for direct-current measurements, and therefore operating on the D'Arsonval principle. The ultimate limitation of such instruments, as far as permanence is concerned, is stability of magnetization of the permanent magnet. This limitation is overcome in the improved direct-current line of meters known as the "Type PL Laboratory Portable Meters," manufactured by the Westinghouse Electric & Manufacturing Co. They are made with extra long scale and strong magnets, which make them especially adapted for use as semi-portable laboratory meters. They operate on the

D'Arsonval principle, a moving coil and permanent magnet, which renders them free from all residual errors.

The PL type meter differs from other meters using the D'Arsonval principle in having a single air gap through which the moving coil, pivoted at one edge, swings. The single gap permits of maximum torque per unit weight for the following reasons:—

1. The magnet will retain a higher permanent strength because the total air gap is relatively narrow and need never be disturbed. The complete movement can be taken out for inspection or repairs without removing any part of the magnetic circuit.

2. The strength of the magnet can be higher in the single-gap than in the double-gap movement, for the magnets of the latter can be only as strong as they would be when the core is out; otherwise they would lose a large part of their strength the first time the core and coil were removed.

3. Since the coil, when pivoted at one side, counterbalances to some extent the weight of the pointer and thus reduces the counterweight necessary when the coil is pivoted in the middle, as with the double-gap movement, the single-gap movement allows of a minimum total weight of movement.

FIG. 1. IMPROVED PORTABLE LABORATORY METER

4. The strong magnets produce a high torque, which, with the light weight of the moving element, gives a high ratio of torque to weight, thus reducing friction errors to a minimum.

The accuracy of these meters is further assured by treating, magnetizing, and artificially aging the magnets with their pole pieces complete, according to the process originally developed by Madame Curie, the discoverer of radium, this process being considered superior to other processes. To guarantee further against change in strength, the magnets, after treating, are stored for 6 months. Any magnets that show a decrease in strength after this time are rejected.

The moving coil and pointer are then assembled in the magnetic structure and the manufacture is completed without disturbing the magnetic circuit. The light metal frame on which the moving coil is wound moves through the air-gap of the magnets and makes the reading inherently dead-beat. This important feature enables readings to be taken quickly and prevents violent fluctuations from injuring the pointer or the moving element.

The scale, which is 11½ in. long, subtends an arc of 100 deg., giving large open divisions, which are of uniform length throughout. The scale has diagonal markings, which facilitate accurate readings of fractions of

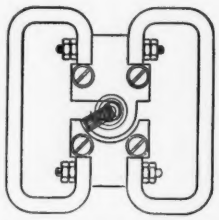


FIG. 2. DIAGRAM OF MAGNET AND COILS OF SINGLE AIR GAP METER

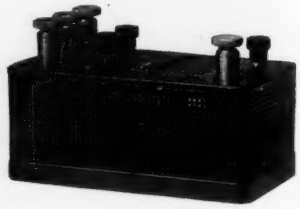


FIG. 3. SHUNT USED IN CONNECTION WITH NEW TYPE METER

divisions. A mirror, extending the entire length of the scale, enables the prevention of parallax in reading.

These meters are mounted in polished walnut carrying cases that have easily removable hinged covers. For use with the millivolt meters, combination laboratory portable shunts are supplied. These combination shunts include 3 shunts of any desired capacity up to 200 amp., mounted in a single box with suitable terminals.

These meters are supplied as voltmeters or as millivoltmeters. The millivoltmeters can be used as ammeters in connection with high accuracy.

New G. E. Single-Phase Watthour Meter

FIGURES 1 and 2 illustrate the new type of single-phase watthour meter as developed by the General Electric Co. and known as their Type I-14. Important features of this instrument are its high initial and maintained accuracy, micrometer adjustments, solid structure, legible register, easy access for inspection and repairs, simple construction, compact design and neat appearance.

They are offered self contained in capacities of 5 to 300 amp., 110 or 220 volts, 2-wire; and 5 to 150 amp., 220 volts, 3-wire, 25 to 133 cycles.

The usual keyholed support is provided in the top at the back of the base casting and the 2 holes for the lower supporting screws are inside the terminal box, so that when the meter is connected and sealed, these 2 lower screws are also sealed. The leads enter the bottom of the box, the brass terminals being permanently molded into place in a noncombustible insulating compound.

The cover is a sheet zinc stamping and has the 2 usual glass-covered openings for observing the register and rotation of the disk.

The rotating element consists of an aluminum disk mounted on a vertical shaft with a worm cut in the upper end, which transmits motion to the worm wheel at the back of the register. The lower shaft bearing is a sapphire mounted in a brass screw, while the top

FIG. 1. TYPE I14, G. E., SINGLE-PHASE WATTHOUR METER

bearing consists of a flexible steel wire, mounted in a removable brass plug supported by the main casting.

The register is of the 4-dial type, and the dial face is of white enamel having a dull finish.

There are 2 current poles and 1 potential pole, and the entire magnetic circuit which is in 2 sections rigidly fastened together by 2 punched iron reinforcing plates, is held in position inside the base by 3 screws.

FIG. 2. TYPE I14, METER WITH COVER REMOVED

Two holes punched diametrically opposite in the disk prevent creeping or turning on potential alone, and the meters are practically unaffected by variations in voltage 10 per cent above or below standard ratings. Ordinary variations in temperature, small changes in frequency met with in lighting circuits or variations of wave form do not affect their accuracy appreciably.

The meter is tested and adjusted at 0.5 power factor and a lagging device, consisting of a rectangular copper punching in the form of a short-circuited loop and attached to the light load plate, compensates the meter for inductive load.

Thwing Capillary Film Recorder

FOR all purposes where frequent records of temperature, speed or pressure must be secured, this Capillary Film recorder is extremely practical, as it can be constructed to give 20, or even more records per minute, making one record from each galvanometer. The device operates as follows:

The groove being slightly tapering, or V-shaped, from top to bottom, the ink does not flow through, and being tapering in its length, the ink is drawn to the farthest part of the groove, from the ink-well. Ink will follow the pen down upon the chart, only as a

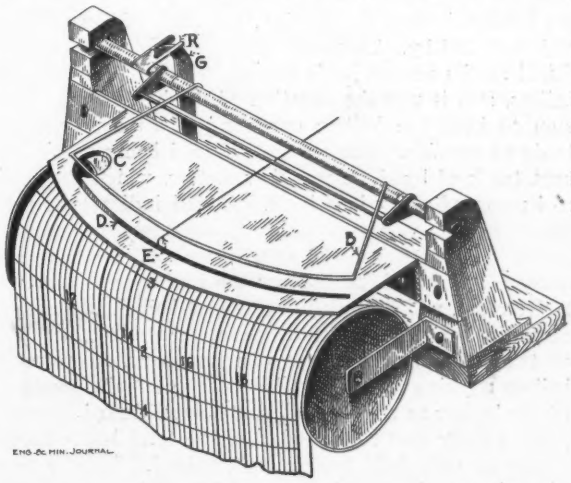


DIAGRAM OF THWING CAPILLARY FILM RECORDER

small drop carried on the tip of the pen to make a dot upon the chart each time it is depressed. In actual use, when the pen has been held against the chart continuously for 27 hr., a very fine line has been ruled upon the chart, but no surplus ink has been deposited.

Wherever temperatures fluctuate rapidly, and it is desired to record each fluctuation, the Capillary Film recorder is an excellent solution of the problem. The thermocouple is constantly in circuit with the galvanometer, and the pen instantly assumes the correct temperature position, when released by the depressor, so that it is in position to be almost immediately depressed for another record. The rapidity of action of this device makes it of great value in power plant practice, in recording the fluctuations of the fire bed temperatures.

This new device is the product of the Thwing Instrument Co., Philadelphia, Pa.

Increasing Power Plant Economy

SOME changes which have been made in the operation of the power house of the Milwaukee Electric Railway and Light Co., are of particular interest, as they have resulted in a 20-per cent reduction in cost of producing current during the last year. One of these was the substitution of an automatic feed on the stokers, which are now all operated from a single direct-current motor, so that no stoker can be fed faster than any other. The vacuum was increased about 10 per cent by removing some 7 per cent of the condensing surface, taking out some of the tubes and giving a freer passageway for the steam to get down to the lower part of the condenser. Before this, there was a back pressure at the top of the condenser, which materially reduced the vacuum possible on the turbine exhaust. Steam flow meters and other recording meters have been installed, which have aided materially in finding where the losses were taking place.

Chiefly, however, the betterment in economy has been produced by proper handling of the boilers. From test it was determined that each of the 765-hp. boilers gave the best result when developing 1200 hp. Each of the 705-hp. boilers at 1000 hp., and each of the 650-hp. boilers at 900 hp. These amounts were, therefore, established as the proper loads respectively for the different boilers, and it was the function of the boiler-room foreman to keep the boilers operating at as nearly these loads as possible. The amount of load being carried is kept track of by the steam flow meters, which are read and recorded every half hour. A load indicator is also placed in the boiler room, and operated from the switchboard, so that when the switchboard operator sees a change in his load, he changes the indicator dial in the boiler room, which reads in developed boiler horsepower, accordingly. The boiler-room foreman can then add or take off a boiler, as may be necessary, to keep all boilers working at the best load. The 30-min. readings of the boilers in service and of the switchboard load are plotted daily and compared, and the total boiler horsepower at each half hour is determined. This is then plotted on a chart with the total kilowatt output curve, and for ideal conditions, the total developed horsepower should show approximately 1 to 1½ times the kilowatts. Any poor operation shown by the curves is referred back to the boiler-room foreman and switchboard operator, with criticism and a request to account for the conditions found.

Book Reviews

EXPERIMENTAL MENSURATION. By H. S. Hedgrove, New York, 1913; 328 pages, with illustrations, trigonometrical tables, and answers to problems, 5 by 8 in. In cloth binding, price $1.25 net.

In this book, a new method of teaching geometry and trigonometry has been adopted, the idea being to lead the student, as far as possible, to discover everything for himself by means of simple experiments. Each experiment is to be carried out and conclusions drawn, and the student is also shown how he might derive these results by deduction from previous experiments, thus constructing a chain of reasoning as well as a system of experiments and analysis.

The subject has been divided rather according to natural relations of the different parts, the first chapter taking up the Methods of Measuring Lengths; the second, Measurements and Properties of Angles; the third, Rectangles and Parallel Lines; the fourth, Construction and Properties of Triangles; the fifth, Parallelograms and Triangles; the sixth, Mensuration of Polygons; the seventh, Circles and Ellipses; the eighth, Properties of the Circle; the ninth, Prisms and Cylinders and the Measurement of Volume; the tenth, the Theorem of Pythagoras with Regard to the Relations of a Right-Angled Triangle; eleventh, Drawings to Scale; the twelfth, Pyramids and Other Solids; thirteenth, Mensuration of Irregular Figures; and fourteenth, the Trigonometrical Solution of Triangles.

In the treatment of the subjects, the interest of the student is held by the method outlined, that is, giving an opportunity to do something with the fact learned, and to discover new facts by experimental measurements. The problems, to a considerable extent, are on direct, practical lines and show just how the information gained may be put to use. While it has something of the atmosphere of the schoolroom and the teacher, it will, nevertheless, appeal strongly to the man who wishes to start the study of these branches of mathematics.

THE TRACTIVE RESISTANCE OF A 28-TON ELECTRIC CAR, by Harold H. Dunn, has just been issued as Bulletin No. 74 of the Engineering Experiment Station of the University of Illinois. This bulletin records the results of tests made to determine the tractive resistance of the car when running on straight track in still air. The tests were planned so as to eliminate wind resistance. Results are finally expressed in the form of a curve whose co-ordinates are car resistance and speed, which shows that the resistance varied between 5.25 lb. per ton at 5 miles per hour, and 26.12 lb. per ton at 45 miles per hour. The bulletin contains also a description of the car. Copies may be obtained gratis upon application to C. R. Richards, Acting Director of the Engineering Experiment Station, Urbana, Ill.

OIL FUELS FOR STEAM BOILERS. By Rufus T. Strohm, 1914. 145 pages and 63 illustrations; price $1.

The greater part of the contents of this little volume appeared as a series of articles in the Electrical World during 1913 and 1914.

The purpose of the compiler of this book is to describe, in clear and simple language, the principles that underlie the use of oil as a fuel in steam-boiler practice; the form and action of various types of burners; the arrangement of furnaces for burning oil under different kinds of boilers; the operation of such accessories as pumps, heaters, and cleaning devices; the methods of storing oil; and such other matters as might naturally arise in connection with the purchase and use of fuel oil.

No attempt is made to describe the use of oil in locomotive practice or in marine work, but the text is confined to the subject of oil burning in stationary steam boilers only.

In the hands of the student or the busy practical man who is in charge of, or is brought into contact with oil burners or oil burning furnaces, the book will well fulfill the aims of the writers.

ACOUSTICS OF AUDITORIUM, by F. R. Watson, has just been issued as Bulletin No. 73 of the Engineering Experiment Station of the University of Illinois. The bulletin describes the acoustical defects of the auditorium at the University of Illinois, showing graphically in the illustrations, the character and paths of various echos which were traced by use of an alternating-current arc-light at the focus of a parabolic reflector, the arc giving forth a hissing sound and the paths of the echoes being located by means of the reflected light and confirmed by means of the sound. A cure for the acoustical defects was found, without changing materially the architectural design of the room. The bulletin should be of value to architects and others interested in this subject.

Copies may be obtained gratis upon application to C. R. Richards, Engineering Experiment Station, Urbana, Ill.

BUREAU OF MINES has issued the following new publications, only a limited number of which is available for free distribution:

Bulletin 73, Brass-furnace practice in the United States, by H. W. Gillett, 1914, 208 pp., 2 pls., 23 figs.; Technical Paper 45, Waste of oil and gas in the Mid-Continent fields, by R. S. Blatchley, 1914, 57 pp., 2 pls., 15 figs.; Technical Paper 70, Methods of recovering oil in California, by Ralph Arnold and V. R. Garfias, 1914, 57 pp., 7 figs.; Technical Paper 73, Quarry accidents in the United States during 1912, compiled by A. H. Fay, 1914, 45 pp.; Technical Paper 75, Permissible electric lamps for miners, by H. H. Clark, 1914, 21 pp., 3 figs. Requests for all papers can not be granted without satisfactory reason. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

ELEMENTARY MAGNETISM AND ELECTRICITY, by Cyril M. Jansky, B. S., B. A.; first edition, 1914, 212 pages, illustrated; New York; price $1.50.

In preparing this text, the author had in mind the needs of students who may have had some practical experience with electrical apparatus or machinery, but whose knowledge of the principles of its operation and of mathematics is limited. To make the principles of magnetism and electricity real to such students, the subject is developed experimentally. The student is expected to perform simple experiments and to observe the actual phenomena. Then, by means of questions and discussions, he is aided in the interpretation of his observations and the formulation of his conclusions into workable ideas.

The test is, as its name implies, elementary, and is intended for individual or home study, although it may be used in class work when a supply of apparatus is available. The apparatus is inexpensive and can readily be made by an ingenious student.

The author starts with the subject of magnetism in the first chapter; then electromagnetism and its application in the second and third chapters respectively. This is followed by electromagnetic induction, current electricity, electrolysis, resistance, flow of current in a circuit, electric generators and motors, work and energy.

As a whole, the book well fills the needs of the person looking for a concise, yet elementary treatise on magnetism and electricity.

MAGNETIC AND OTHER PROPERTIES OF ELECTROLYTIC IRON MELTED IN VACUO, by Trygve D. Yensen, has just been issued as Bulletin No. 72 by the Engineering Experiment Station of the University of Illinois. The bulletin shows how it is possible to produce iron of an exceptionally good magnetic quality by melting pure iron in a vacuum furnace. While iron melted under other conditions is apt to be contaminated by carbon or oxygen to a greater or less extent, iron melted in vacuo is not only prevented from absorbing such impurities, but is actually purified in the process. These facts are illustrated by a large number of curves and numerous photographs showing the crystalline structure of the iron.

Copies may be obtained gratis upon application to C. R. Richards, Engineering Experiment Station, Urbana, Ill.

Catalog Notes

ALLIS-CHALMERS MFG. CO. Milwaukee, Wis., lately issued its Spanish catalogs, Nos. 100 and 103.

GRINDING is the title of a booklet just received, in which the subject of grinding as applied to valves, is fully described and illustrated. A copy can be obtained by addressing The Lunkenheimer Co., Cincinnati, O.

ICY-HOT bottles, jars, carafes and luncheon cases, for keeping contents icy cold 72 hr. or steaming hot 24 hr., are described and illustrated in catalog No. 17 from The Icy-Hot Bottle Co., 122 West Second St., Cincinnati, O.

FROM STOW MFG. CO., Binghamton, N. Y., we have just received the company's latest catalog, No. 14, containing 96 pages. Aside from belting, drills, shafting, etc., manufactured by the company, this catalog contains a complete line of portable electric tools.

FOLLOWING THE RECENT "Safety First" movement, several states are drafting Safety Appliance Laws, among the provisions of which are requirements that riveting hammers embody in their construction devices to prevent the accidental ejection of the rivet set from the nozzle of the hammer. A novel rivet set retainer is that now put out with the "Little David" pneumatic riveter, and described in a bulletin from Ingersoll-Rand Co., 11 Broadway, New York.

The retainer consists of a single piece of heavy spring steel, closely wound into a spiral form. One end of this spring fits over the outside of the hammer nozzle and hooks over a projection integral with the nozzle. The other end is wound to a smaller diameter. Sets for rivets over 7/8 in. diameter are formed with a coarse thread and are simply screwed into place. Sets for rivets 7/8 in. diameter and smaller are formed with a shoulder and are slipped into the retainer while it is detached from the hammer, the shoulder holding it in place. A photograph shows the hammer running free under 90 lb. air pressure, the device preventing the rivet set or piston from being driven out.

DURING THE SUMMER MONTHS, especially, the problem of securing suitable drinking water is one that faces every factory manager.

That temperature is an important consideration, is shown by the interesting experiments of Dr. Thomas Darlington, Secretary of the Welfare Committee of the American Iron and Steel Institute. He found that the range of temperature at which water is palatable is extremely limited. Water is most enjoyable when at 50-55 deg. F. At this temperature, it has a stimulating action on the heart, and relieves fatigue and exhaustion, by equalizing the temperature of the body. Water which is warm is insipid and uninviting. Water which is very cold, it is well known, is liable to cause violent illness, such as cramps, prostration, etc. Absences and inefficiency, particularly during the summer, have been definitely traced, in many cases, to the lack of a proper drinking water supply.

In a unique system, known as the J-M System, the water is cooled to the right temperature by the A-S refrigerating machine and is then piped to bubbler fountains placed at advantageous locations throughout the plant. To run this machine, it is necessary merely to throw on a switch. To stop it, pull the switch. A thermostat connection is arranged, to start and stop the machine at certain temperature limits, thus automatically keeping the water at a uniform temperature all the time.

An interesting booklet describing this system in detail has been issued by the H. W. Johns-Manville Co., New York.

WESTINGHOUSE RAILWAY DATA Exchange No. 8, just issued by the Westinghouse Electric & Mfg. Co., deals with the efficient use of cars, giving considerable data as to the relative cost of operation of different systems. The cost of stops is also treated and some interesting data in dollars and cents given as to the cost of different lines.

Trade Notes

THE THREAD TIGHT CO. has changed its location from 2 Rector St., to 54 Broadway, New York City, and all correspondence should be sent to the latter address.

NORDBERG MFG. CO., of Milwaukee, Wisconsin, is now building Diesel Engines, having recently entered into an exclusive manufacturing arrangement with Usines Carels Freres, of Belgium. The design of the Nordberg Carels Diesel Engine is under the direct supervision of B. V. Nordberg.

PENBERTHY INJECTOR CO., Detroit, Mich., has recently received the following letter from E. G. Stewart, Fleming St., Coraopolis, Pa.:

"My injector has played out. It has given 18 yr. of service; it was a Penberthy, and I want another one. The one I have is size DD.

"In winter we carry 90 lb. steam pressure and in summer 20 lb.; 100-hp. return tubular boiler and a water pressure of 45 lb.; would the nonlifting automatic injector be all right? I think it would, and could I get it with 1¼-in. connections?"

PRACTICAL ENGINEER.

Trade-mark, Reg. U. S. Pat. Off.

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Stipped plates used, but no heavy, black and white plates.

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Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

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Wanted

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Secretary of local Engineers' Association to write at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

WANTED—A small ice-making and refrigerating plant with a daily capacity of about 10 to 15 tons is wanted by a subscriber. A second-hand plant preferred. Give full particulars. Address. Box 341, Practical Engineer. tf.

MR. ENGINEER—If you are tired of the daily rut of your job, and are ambitious to make a way for yourself in the selling end of the engineering line, we have something unusual to offer you. Become a sales engineer and earn three to six times as much as your present salary. You can do it without any risk whatsoever, but you must possess certain qualifications. Write us and we will tell you if you are eligible. We manufacture boiler appliances of the highest merit and standing, selling as high as $400 per boiler, and yielding in commissions as high as $100 per boiler. One sale may mean more than your week's salary. Write us. Box 349, Practical Engineer. tf.

WANTED—Every local Engineers' Association to have an assortment of valuable power-plant books—Secretary, write at once for full particulars. Address, Dept. C, Practical Engineer, Chicago.

WANTED—A few hustlers to take orders for Zinco Soot Destroyer. Quick Sale. No competition. Good proposition. New York Supply Exchange, Ford Bldg., Detroit, Mich. tf.

Help Wanted

WANTED—To report August 15th to September 1st, a competent engineer to take charge of a 600-kilowatt, direct-current, two-unit, street railway power plant in Northern Illinois. Have cross compound condensing engines, water tube boilers, water softener, etc. Applicants must be of good habits and possess requisite experience and ability for successfully maintaining and operating above described plant. In first letter state age, experience, salary desired, when can report, and other details. Address Box 358, Practical Engineer. tf.

OWNERS OF WATER WORKS SYSTEM in Southern town having 30,000 population, are considering engagement of man to take charge of pumping plant, containing fly wheel pumps and mechanical gravity filters, 10,000,000 gallons capacity. Must be well trained, sober, industrious and resourceful in emergencies. Write giving full particulars and salary required. Address Box 359, Practical Engineer. 8-1-1

MASTER MECHANIC wanted for woodworking factory employing 700 men. Power plant 1,000-hp. Mut be practical steam engineer with knowledge of electricity; machinist, and should have experience in maintaining woodworking machinery. Above all, must be tactful and good executive. Salary $3,000.00. Apply, with full particulars, to The Engineering Agency, Inc., Monadnock Block., Chicago, Ill. (21st year). 8-1-1

CHIEF OPERATING ENGINEER WANTED for Electric Power Station, equipped with Sterling boilers, Curtis turbines and General Electric generators Salary $2,000.00 to $2,400.00. Apply, with full particulars, to The Engineering Agency, Inc., Monadnock Block, Chicago, Ill. (21st year.)

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED—An additional subscription solicitor wanted to cover towns in the State of Oklahoma. Excellent chance to earn extra money. Write to Subscription Department. tf.

For Sale

FOR SALE—550-volt, 60-cycle, 3-phase alternating current motors, complete with starting boxes. 1 50-hp., $310; 1 30-hp., $216. 110-volt, d.c. motors: 1 10-hp., $150; 1 3-hp., $72. All cash, 30 days. Parks & Woolson Machine Co., Springfield, Vermont. 7-15-4

CARR VENTILATED FURNACE ARCH for all types of boilers and furnaces, gives 100 to 400 per cent greater service than any other kind. Write for information, giving number and kind of boilers and furnaces. Elmert E. Carr, 231 Insurance Exchange Bldg., Chicago, Ill. 7-1-4

AN ENGINE BARGAIN—1 Hewes & Phillips Cross Compound Horizontal Engine, 16⅛-in. and 28-in. by 42-in., 450-hp., at 100 lbs. pressure, 12-ft. by 40-in. flywheel, floor space, 18 ft. by 25 ft. 1 Watts-Campbell, Single Cylinder Horizontal R. H. Corliss Engine, 18-in. by 42-in., 150-hp. at 100 lbs. pressure, 12 ft. by 30 in. flywheel, floor space 10 ft. by 24 ft. 1 Watts-Campbell, Single Cylinder, Horizontal R. H. Corliss Engine, 16 in. by 42 in., 125-hp. at 100 lbs. pressure, 12-ft. by 30-in. flywheel, floor space 10 ft. by 24 ft. 1 Wm. Wright, Single Cylinder, Horizontal Old Type Corliss Engine, 16⅛ in. by 30 in., 75-hp. at 85 lbs. pressure, 12 ft. by 32½ in. flywheel, floor space 18 ft. 10 in. by 6 ft. 8 in., side crank, 4-valve releasing gear. All the above in first class condition. Address Box 360, Practical Engineer. 8-1-1

GENERATOR FOR SALE—1 20-kw., Type S, 22-frame, 240-rpm., 115-volt, No. 143262, style No. 0221A, Deihl generator. This machine is absolutely new and can be bought direct-connected to Otto gas engine or can be purchased separate. Address all inquiries to Mr. H. E. Sechrist, 403 Lippincott Bldg., Philadelphia, Pa. 8-1-1

50-LIGHT DYNAMO, $65, in payments of $5 per month. Box 161, Troy, Ohio. 8-1-1

GROBET SWISS FILES are the standard of excellence in files, and have been for over 100 years. We send post paid, as an introducer, 48 files especially adapted for tool makers and machinists on receipt of $5.00. This is a chance to get a set of files you'll appreciate and we'll get future orders. Montgomery & Co., 101 Fulton St., New York, N. Y. 8-1-1

BOILERS—Two 250-hp. Babcock & Wilcox water tube boilers, insurance certificate 160-lb. steam pressure, each $1,000. Two 220-hp. Heine water tube boilers, insurance certificate 150-lb. steam pressure, each $900. One 16x38 Hughes & Phillips Corliss Engine, $500. Duzets & Son, 50 Church St., New York. tf.

FOR SALE—At a Bargain. New 5 by 6, 4-cylinder, governor-controlled engine, fully equipped with carburetor magneto. Will sell for much less than cost. Fred Hanson, 570 Prior Ave., St. Paul, Minn. tf.

FOR SALE—One 12-hp. gasoline engine. Cheap for quick buyer. Geo. J. Spengler, R. 2, Siegfried, Pa. 8-1-1

Patents and Patent Attorneys

PATENT YOUR INVENTION. Send sketch for free expert search and report as to patentability. Books on inventions and patents, and books of references from congressmen, manufacturers, bankers and inventors sent free. John S. Duffie & Co., 612 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman Patent Lawyer, 624 F St., Washington, D. C. tf.,

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information. tf.

OFFICIAL DRAWINGS FREE. Patents procured or fee returned. Expert services. Send sketch for Free search. The Patent Exchange, Garban Bldg., Washington, D. C. tf.

FOR HONEST advice and real patent at Low Cost, consult John O. Seifert, Patent Attorney, 50 Church St., New York. 5-15-6

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

WE GUARANTEE our device will remove scale, mud, and keep a boiler from foaming without the use of compound; to prove this we will let you try one 30 days without cost. Before buying any machine write for booklet and compare ours with other makes and see which is best. Lincoln Boiler Cleaner Co., Lincoln, Ill. 7-15-4

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

Sparks From The Advertising Pages

One of the notable accomplishments of the Annual Convention of the Associated Advertising Clubs of the World, held at Toronto, June 21-25, was the adoption of Standards of Advertising Practice by the Technical and Trade Pulbications.

One advertiser neatly designated them as "The Ten Commandments of Advertising" so although they are primarily addressed to advertisers, the printing of them on this page, will enable you to realize the moral foundation of technical advertising and the extent to which your interest (the subscriber's interest) are considered in the gatherings of the advertising clan.

BUSINESS PAPERS

The publisher of a business paper should dedicate his best efforts to the cause of business and social service, and to this end should pledge himself:

"1. To consider, first, the interests of the subscriber.

"To subscribe to and work for truth and honesty in all departments.

"3. To eliminate, in so far as possible, his personal opinions from his news columns, but to be a leader of thought in his editorial columns, and to make his criticisms constructive.

"4. To refuse to publish 'puffs,' free reading notices or paid 'write-ups'; to keep his reading columns independent of advertising considerations, and to measure all news by this standard: 'Is it real news?'

"5. To decline any advertisement which has a tendency to mislead or which does not conform to business integrity.

"6. To solicit subscriptions and advertising solely upon the merits of the publication.

"7. To supply advertisers with full information regarding character and extent of circulation, including detailed circulation statements subject to proper and authentic verification.

"8. To co-operate with all organizations and individuals engaged in creative advertising work.

"9. To avoid unfair competition.

"10. To determine what is the highest and largest function of the field which he serves, and then to strive in every legitimate way to promote that function."